ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. LII. No. 1. NEW YORK, SATURDAY, JANUARY 4, 1908. ISSUED WEEKLY

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NEW YORK
PUBLISHING OFFICE . . . . . 13-21 PARK ROW
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NEW ENGLAND OFFICE . . . . . 95 MILK STREET
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REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States $3.00
One Year, Canada 4.00
One Year, Foreign Countries 6.00
Single Copy, 10 cents. Back numbers, beyond one month, each . . .25

ADVERTISING

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noón* to assure publication in that week's issue.

Published weekly by the ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York. Charles W. Price, president and treasurer; Stephen H. Goddard, vice-president; H. S. Tuthill, secretary.

Entered at the Post Office at New York as second-class matter under the Act of March 3, 1879

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RAILWAY ELECTRIFICATION IN SWEDEN.

For several years past the Swedish Government has been conducting experiments in electric traction, in order to determine whether some such system might be installed successfully and economically on the country's railways, it being contemplated to utilize Sweden's many water powers for this purpose.

Sweden is fortunate in having three and three-quarter million horse-power in waterfalls, much of which is favorably located for development. At the present time, not much electrification has been carried out in Sweden, comparatively speaking, but the results of experiments have been so favorable that it is thought that work will be begun before long which will ultimately convert to electric traction all but two of the railways lying south of a line one hundred and fifty miles north of Stockholm. The experimental work has been under the direction of Mr. Robert Dahlander, electrical engineer for the railway department, and he has recently submitted a report based upon the results of this work. Mr. Dahlander early decided in favor of the single-phase system, and this system only is considered in the estimates given in his report, which appears in abstract on other pages of this issue.

The scheme suggested consists, in brief, of a single-phase system supplied at a potential of 15,000 volts at the contact wire, from five power stations. Power may be transmitted either at 50,000 volts and transformed down to the operating potential, or a three-wire system might be adopted, with transmission at 30,000 volts, the step-down transformers being eliminated. The contact wires are to be supported from poles placed alternately on each side of the track where the latter is a single track, or opposite on both sides where the track is double. The plan outlined contemplates double-tracking most of the railways within the next ten or twelve years, all plans of work being laid out with this object in view. The total mileage to be electrified is about 1,300, seventy miles of which is double-tracked.

All the power stations are to use waterfalls now owned by the government, but auxiliary plants, where peat will be the fuel used, are proposed in connection with two of the stations. The plans contemplate rather moderate speeds, the average express speed being about thirty-seven miles an hour, and the speed of passenger trains about twenty-eight. These, however, are said to be considerably faster than the equivalent speeds now maintained by the steam trains. The report goes somewhat deeply into the financial consideration of the proposed change. The results are about as follows:

The cost of the electric locomotives, there being nearly three hundred of these, will be about eight and a half million

dollars. The cost of the transmission lines, power stations, substations, etc., will be something over sixteen and a quarter million dollars. The cost of operating the electrical system is estimated at one million, five hundred and eighty thousand dollars, interest, depreciation, and everything being allowed for. The cost of steam locomotives to give an equivalent service is estimated at seven and three-quarter million dollars. The cost of operating by steam would be one million seven hundred thousand dollars. These figures include interest, depreciation, and all other charges. There thus remains a difference in favor of the electrical system of about one hundred and twenty thousand dollars a year, which is seven per cent of the cost of operating by steam.

It is interesting to compare the last figures with the estimates given recently by Mr. W. S. Murray of the saving which would be effected by the single-phase system on the New York, New Haven & Hartford road as at present installed. He estimated that the saving would be about ten per cent of the operating cost.

This saving which has been figured out with the Swedish railways relates to the present time only. The computed saving for the year 1920 would be four hundred thousand dollars annually. Actually, it would probably be much more, as Sweden now imports her coal from foreign countries and the price is constantly going up. When she uses her waterfalls for this purpose will avoid this expense and will be turning to advantage resources which are not consumed.

MECHANISMS CONTROLLED BY SOUND.

In the issue of the ELECTRICAL REVIEW for December 28 was an interesting article by Dr. Edouard Branly, describing the latest improvements in his tele-mechanic system, by means of which he controls mechanisms from a distance through the agency of electric waves. In this issue is given a brief description of an interesting device constructed by Mr. John Gardner for accomplishing the same purpose, using, however, as his agent, sound waves instead of electric. Although at first the two systems seem to be entirely different, the principles of operation are very similar. Dr. Branly uses electric waves for affecting a coherer sensitive to such disturbances; Mr. Gardner uses sound waves, causing these to set into vibration a steel spring which in turn communicates its motion to a microphone, this device operating as an "anti-coherer" for sound. The change in the resistance of the microphone, due to the motion communicated to it, is caused to close a relay so that any desired action may then be brought about, and by a proper combination of microphones and springs a selective arrangement is secured.

For short distances this system of control might be very serviceable, but the most promising application for it is that suggested by the inventor, which is that it be used in connection with submarine bell signaling, for which purpose it might be much more sensitive than the present type of receiver, and besides it possesses the advantage of being able to produce a visual signal. We are beginning to appreciate more thoroughly the advantages of being able to communicate with unseen vessels. Heretofore the only means available were such as failed almost completely in fogs at the very time when they were most necessary, but to-day we have several methods available for this. We have the wireless telegraph and telephone systems, as well as the submarine sound signals, and it should not be long before that most dreaded danger of ocean travel, fog, should be rendered innocuous.

ELECTRIC MOTORS IN CHURCHES.

A well-recognized field of usefulness for the electric motor is in connection with organ-blowing in churches. A large number of these installations have demonstrated their attractiveness to central stations, particularly on account of their load characteristics. In the operation of ventilating fans also the electric motor has given the same satisfactory service in church-auditorium air supply and exhaustion that has characterized its use in secular institutions. Clean and noiseless, efficient and costless to hold in readiness for instant service, the motor of moderate capacity needs no defense in locations where the most refined taste and strict prohibition of noise exist.

Few churches have made other applications of electricity than for ventilation, lighting, sign work in the mission field, and for organ operation, but an installation just completed in the new $200,000 First Baptist Church of Worcester, Mass., illustrates how much broader the field of the small motor is in such work than is generally appreciated.

In the Worcester installation the church lighting is worked out on a thoroughly scientific basis, various arrangements of incandescent lamps being used to produce effects utterly out of the question with gas. Translucent panel boxes with softening plates of pleasing color are used at points in the choir gallery and in the main auditorium where the light is necessarily visible to the congregation, and no sharp, direct ray falls upon the eye at any point. The general illumination, provided by incandescent lamps spaced around domes and archways, is distributed evenly without offense to the most sensitive retina.

It is in the motor installation, however, that the newer applications find expression. Five motors are in service, aggregating thirty horse-power. The largest motor drives a fan in connection with the heating system, and is rated at ten horse-power. The organ-blower is operated by an eight-horse-power motor, and a fan for the ventilation of lavatories is driven by a four-horse-power motor. No brooms or sweepers are used in cleaning the church, the installation of a vacuum cleaning system, driven by a four-horse-power motor, rendering this unnecessary. A vacuum of eleven inches is ordinarily available at outlets scattered through the various parts of the building, and the labor cost of cleaning has been greatly reduced, in comparison with the expense which would be necessary under the old methods of hand work.

Perhaps the most interesting motor application in the church is the operation of a wood, canvas and asbestos curtain between the main auditorium and the Sunday-school room behind, by a four-horse-power motor wound, as are all the others, for 500

volts direct current. This curtain is about thirty-five feet wide and thirty feet high, weighing about three tons. It can easily be raised in from a quarter to a half minute, the operation being practically noiseless. The motor is a slow-speed machine, located in the loft of the church, and is controlled by a speed rheostat and starting box located in a locked receptacle on the wall of the main Sunday-school auditorium. The latter seats about 600 and the auditorium of the church proper, 900, so that by a single movement of the controller the curtain can be raised silently during services, and the capacity of the church increased over sixty-six per cent. The motor installation requires little attention, and the church is in no way injured, either in appearance or in use, by these five applications of power. The load comes on at times when the ordinary power load is light, and is desirable on account of its steadiness, no less than because of its non-peak characteristics.

THE SPREAD OF WIRELESS TELEGRAPHY.

During the reading of a paper on "Wireless Communications Over Sea" before the Institution of Engineers and Shipbuilders of Scotland, the author, Dr. J. Erskine-Murray, gave some interesting figures regarding the use of this new method of communication. From data which he had been able to get together, he found that there are now 1,550 wireless telegraph stations in operation. Of these, 195 are in commercial land stations, 170 are on merchant vessels, 150 are installed in lighthouses, 670 are naval installations, and fifty-five portable military installations. These are all intended for actual service, with the possible exception of the military stations. The remaining 310 are experimental stations.

There are, therefore, nearly 1,200 wireless telegraph stations in actual service, which is an excellent showing when one considers that the art is only about ten years old, and progress was necessarily slow at first.

Another significant statement was that a vessel can always keep in wireless communication with England as long as she is not more than seventy miles from the coast. We used to be told that a vessel sailing around Great Britain need never lose sight of a lighthouse, but to-day she can make a much larger circle and still keep in communication with land, which is more than mere seeing.

AN ELECTRIC FORGE IN A MINE.

An interesting adaptation of electric heating has been made in the Village Deep Mine, in the Transvaal, South Africa. The drills used in the mine require frequent sharpening, and heretofore it has been necessary to carry them to the surface every time this was required. It seems, moreover, that the smiths there are not any too skilful, as they have not been able to handle the best quality of steel without burning it; in consequence of this a poorer quality has been used, as this is not so much injured by overheating. These difficulties, it is said, will be overcome by the use of an electric forge which has been devised. These forges may be operated in the mine itself, thus avoiding sending tools up to the surface; and they are under good control, so that there is little or no danger of overheating. Tests of the new forge are now being made, and the results indicate a considerable saving in labor and tools. If no difficulty is experienced in sharpening drills made of the best steel in this furnace without damage to the material, a considerable advantage will have been gained for mining work.

THE EFFECT OF RADIUM ON OTHER MATERIALS.

So much interest has been shown in Sir William Ramsay's announcement that the emanation from radium appeared able to bring about a transmutation of certain elements that his most recent explanation of what he has done is acceptable. At a recent meeting of the Society of Arts, at London, Sir William gave a popular lecture, explaining just what he believed had been accomplished. He showed that radium decomposes water, setting free hydrogen and oxygen, and at the same time gives off the so-called "emanation." The three gases may be collected together and the emanation separated by exploding the hydrogen-oxygen mixture, but a peculiar effect is found since there is always some hydrogen remaining. This effect has not been fully explained, for while it is possible that hydrogen-peroxide might be formed, this explanation does not seem to be complete. The emanation when collected seems to be in an unstable condition, for it immediately begins to contract, the volume being only one-half of the original after one and a half hours. The original volume can be recovered by heating, but on cooling contraction again takes place. The suggested explanation of this is that a molecular change takes place, the atoms or molecules of the emanation combining to form new molecules. This change in volume is complicated by the more interesting change into helium which is taking place, one-tenth of the emanation going to form this element and the rest changing into another form of radium.

It was this peculiar effect of the emanation on water, producing an excess of hydrogen, that led to Sir William's most striking experiment. Mr. Alexander Cameron, in studying this effect, said that he had found neon in the vessel after the hydrogen and oxygen had been removed. Sir William, in an attempt to account for this, exposed a solution of copper sulphate to the action of the emanation. In this case no helium was found in the gases, but they did contain argon, and, moreover, the solution of copper sulphate contained lithium and sodium. The latter might have been given up by the glass containing vessel, but the presence of lithium could not be explained in this way. It is significant that both lithium and sodium belong to the same chemical group as copper, while the emanation itself is an inert gas not attacked by any reagent, a feature which is characteristic of the group containing helium, neon and argon. Another confirmation of these effects is the apparent change which takes place in the emanation set free by thorium. Here the residual gas is found to contain carbon-dioxide, the carbon apparently resulting from the degradation of this emanation itself.

These experiments are most interesting, and further work in this direction will be watched closely. One difficulty is the scarcity of radium. The largest quantity which has yet been produced at once is forty-six grains, part of which Sir William was fortunate enough to secure.

WIRELESS COMMUNICATIONS OVER SEA.[1]

BY J. ERSKINE-MURRAY.

Although the principal subject of the present paper is electrical wireless telegraphy, it may be as well to commence with a short survey of marine communications in general, since, owing to a vessel's motion, all methods of communicating with it are necessarily "wireless." In every case some type of wave motion is used as the means of transmitting the signal or message. Sound, which is one of the commonest, and perhaps the simplest form of wave motion, has served since the first dug-out canoe of prehistoric times was launched, and will continue to be of use as long as the human voice exists. That extremely simple instrument, the speaking trumpet or megaphone, renders communication easy up to several hundred yards in moderate weather, and only fails when the sound is drowned by other noises, or when a high wind carries it upwards and backwards, and so prevents it reaching its destination. The siren, though much more powerful than the megaphone, suffers, but in a less degree from the same disadvantages, and since it is slow in action and occasionally fails and splutters at critical moments, is not of much use for anything but the simplest of signals. One great disadvantage of the whistle or foghorn as a means of indicating the presence of a vessel during thick weather is that, owing to the quality of its tone, the air seems to be filled with sound, and the ear can not determine whence it comes. A deep note is essential in order that the sound may carry a long distance, but the quality of tone of an ordinary whistle or horn is about the worst that can be used in cases where it is important to distinguish the direction from whence the sound comes. What is wanted is a note rich in the upper harmonics, like the sound of a trumpet or motor horn, and not a pure tone like an organ pipe, to which the modern siren more nearly approximates.

Submarine Signaling—For very many years it has been known that sound travels far more easily in the sea than in the air. The sea, except just at the surface, is quiet and free from turbulence; there are no currents running at more than a very few miles per hour, and vortex motions, which are probably the greatest hindrance to the propagation of sound in air in stormy weather, are extremely rare. In addition, the actual speed of transmission of sound is much greater in water than in air, the values being about 1,100 feet a second in air, and 4,700 feet a second in water. It is only recently, however, that any considerable advantage has been taken of these most valuable properties of the sea itself. Perhaps the long delay has been on account of the difficulty of satisfactorily conveying the sound from the water to the ear of the listener. Recent experiments have, however, entirely overcome this difficulty, and it is now possible to hear in a telephone on the bridge of a ship the sound of a bell rung under the water from ten to twelve miles off. This system of submarine bell signaling has been much developed during the past few years, and it may be of interest to note that up to last July not less than 294 vessels, chiefly belonging to passenger lines on the North Atlantic, and seventy-four lightships, have been equipped with submarine bells and apparatus for the reception of submarine signals from a distance. Bells which are intended to act as fixed points by which vessels can find their course are usually made to strike a distinctive number of strokes after the manner of a flashing light.

This method of wireless sound signaling has already proved of great assistance to navigators during foggy weather, and the fact that it is possible by its means to locate the direction of the buoy or lightship to which the bell is attached, with very considerable accuracy, from a distance of several miles, gives it an advantage over most other signaling systems, which will certainly lead to its adoption in the near future in all narrow waters where fog is of frequent occurrence.

Sounding by Sound—Some years ago the writer devised a method of sounding by means of the echo from the bottom of the sea, and more recently the matter has been taken up independently by an American inventor. The attainment of satisfactory results depends on the solution of a simple and well-known problem, *viz.*, the measurement of the short interval of time between the moment at which the sound wave is started from the ship and the moment at which it returns as an echo from the bottom. On account of the high velocity of sound in water the time taken for the echo to return from depths less than twenty or thirty fathoms is so short that it is difficult to register, but for greater depths there is no difficulty on this account. The apparatus would therefore not displace the lead line, or Lord Kelvin's sounding machine, except as a very rapid means of taking deep-water soundings, such as would often be advantageous on approaching a coast at high speed or in foggy weather.

Signaling by Light—Passing by the well-known methods of flag and semaphore signaling, of Colomb's flashlight code, and of rockets and arrangements of lanterns, I may mention the recent developments of photophony, or light-telephony, a system of communication invented by Graham Bell in 1879, but only in recent years brought to the stage of practical utility. Telephone messages have been transmitted by means of a beam of light from a searchlight to a distance of eight or ten miles, the sender's voice being heard with perfect clearness. The system, however, suffers from the great disadvantage common to all visible signals, whether lighthouses or more complex arrangements, that they become useless during foggy weather and in snowstorms. It is somewhat strange that mariners should have had to depend for so long on a type of signal which is bound to fail just at the moment when its aid is most needed. The explanation is, of course, that up till recent years mechanical and electrical apparatus were too much of a mystery, and required expert handling. This is now no longer the case, and means of signaling more certain in themselves than the older methods, though demanding a small modicum of technical knowledge and manipulative skill, are rapidly being added to the time-honored methods, and will, to a certain extent, displace them in the future.

Electric Wireless Telegraphy—I shall not attempt a technical description of the apparatus used in any system of wireless telegraphy, but shall confine myself to its application to nautical purposes and to general principles which define its scope and the advantages and disadvantages of the various systems at present in use. In order to indicate the magnitude of the wireless telegraph system of communications throughout the world, I have collected the following data from various government and other reports on the subject:

Total number of wireless telegraph stations 1,550, which may be classified as follows:

Commercial land stations	195
Merchant vessels	170
Lighthouses, etc. (Government stations)	150
Naval installations	670
Military portable installations	55
Experimental stations	310

These 1,550 stations have been erected by the various companies in approximately the following proportions: Telefunken, forty-one per cent; Marconi, twenty per cent; De Forest, six per cent; Lodge-Muirhead, three per cent; Fessenden, three per cent; other systems, twenty-seven per cent.

[1] Abstract of paper read before the Institution of Engineers and Shipbuilders in Scotland, December 17, 1907.

As regards commercial land stations: Marconi, thirty-two per cent; other systems, sixty-eight per cent.

On merchant vessels: Marconi, fifty-six per cent; other systems, forty-four per cent.

The actual proportions in different regions are very various. On the North Atlantic the Marconi Company has a greater hold than elsewhere, though it is very far from having a monopoly, even in the British Islands. In South America, the West and East Indies, and on the Continent of Europe, excepting Italy, the Telefunken, Lodge-Muirhead, and De Forest companies practically do all the business. It has, therefore, been necessary for shipowners, whose vessels trade in these regions, to adopt a system other than the Marconi.

General Principles of Wireless Telegraphy—These may be summed up shortly, as follows:

1. The energy which transmits the signal is propagated over the earth's surface as an electric wave motion.

2. This wave motion, or alternate current, may be either uniform like an ordinary lighting or power current, or it may be in the form of damped wave trains, *i. e.*, in short series of waves following one another at comparatively long intervals; each series or train commencing strongly and dying out after comparatively few waves. In the first case a high-frequency alternate-current generator, or a vibrating electric arc may be used; in the latter, the intermittent spark discharge of a condenser.

3. In both cases it is necessary that the frequency of the current (number of alternations per second) should be high in order that the amount of electricity set in motion at each wave, and, therefore, the actual dimensions of the apparatus, may not be too large. This will be appreciated when it is recollected that a small quantity of electricity, or any material, when moving very rapidly, may transmit a large amount of energy. (A high-speed de Laval steam turbine is a good mechanical instance of this.) A high frequency is thus advantageous from an engineering point of view, though it is not absolutely necessary.

4. The receiving apparatus must, therefore, be capable of detecting and indicating currents whose frequencies are greater than 100,000 per second. There are now scores, possibly hundreds, of ways in which this may be done. These may be classed as follows:

(*a*) Imperfect electrical contacts, or coherers, whose resistance is changed by the action of the received current;

(*b*) Electrolytic detectors, which indicate the received currents by an alteration in polarization;

(*c*) Thermometric detectors which indicate the current through the effects of the change of temperature it causes;

(*d*) Magnetic detectors in which the magnetic state of a piece of magnetized iron is altered by the current;

(*e*) Electromagnetic detectors on the current balance, or electro-dynamometer principle;

(*f*) Valves or rectifiers, which, owing to their property of permitting current to pass more easily in one direction than the other, produce a more or less unidirectional and, therefore, measurable current directly from the alternating current received;

(*g*) A miscellaneous class whose methods of action have not yet been explained.

The best-known forms of coherer are (1) the Marconi, consisting of a glass tube of about five millimetres bore in which are two silver plugs about 0.5 millimetre apart, between which a small quantity of very fine nickel filings are placed. The gap is usually V-shaped to admit of regulation by merely turning the tube, as the filings only occupy about one-third of the space, and are, therefore, more or less crowded together according as the wide or narrow end of the V is uppermost. (2) The Lodge-Muirhead, which consists of a razor-edged steel wheel about the diameter of a threepenny bit, whose edge dips into mercury covered with oil, and which is kept revolving by clockwork. The Marconi coherer, which is a modified form of Branly tube, and is also used by the Telefunken Company, requires to be decohered by tapping or shaking it after it has recorded a signal, as it would otherwise remain cohered. This, though apparently a disadvantage, is in reality the essence of its success, for it is owing to this that it was first possible to maintain the effect of the passage of the high-frequency current long enough to obtain from it a permanent record of the Morse tape by means of ordinary telegraph instruments. The Lodge-Muirhead coherer is decohered after a small fraction of a second by the movement of the wheel.

The other detectors most in use are Marconi's magnetic detector and the electrolytic receiver, or barretter, invented by Fessenden. Magnetic detectors are based on the fact that a high-frequency current, even if of very short duration, may produce considerable changes in the magnetism of a fine magnetized iron wire. In Marconi's form an endless band of fine iron wires is kept traveling round two pulleys. Surrounding one of the straight pieces between the pulleys is a small glass tube on which are wound two coils of fine insulated wire. One of these is connected to the aerial and earth wires, and the other to a telephone receiver. Two permanent magnets are placed so that their lines of force include part of the traveling iron band in their circuit. The motion of the band draws the lines to one side through the retentiveness of the iron for magnetism. The high-frequency current in the aerial wire, on passing through the small coil round the iron band, suddenly demagnetizes it, or rather releases the lines of force. These spring back into a position at right angles to the band, and in so doing cut the coil connected to the telephone, induce a current in it, and thus produce an audible click in the instrument. The motion of the band soon draws the lines aside again and renders the apparatus ready to indicate a new signal. The Morse "dash" is, of course, represented, as in all systems of wireless telegraphy, by a close succession of dots.

The electrolytic receiver, or barretter, depends on the fact that if a constant voltage be applied between electrodes dipping into an electrolyte, one of which is of very small area, the current is, under certain conditions, unstable, and the sudden superposition of a high-frequency current causes a sudden and considerable increase in the direct current. The action is not yet properly understood, though many theories have been stated. A telephone is generally used in connection with this detector, which is one of the most sensitive of all.

It is noticeable that in the above list of detectors of high-frequency currents there are very few, if any, which give directly an audible or visible indication of the signal. In practically every case it is thus necessary to have some auxiliary instrument to indicate to the operator that the detector has reacted. In some cases a telephone, syphon recorder, or Morse inker, may be used at will, in others the telephone is the only auxiliary suitable, and it is, therefore, not possible to obtain a permanent record of a message.

5. The waves are propagated outward from the transmitting station, either equally in all directions, or with a maximum in one direction according as the aerial wire is vertical or inclined. In the latter case the strongest transmission is in the direction of the lower end of the wire. This method is used at Clifden and

Glace Bay, Marconi's transatlantic stations, and at Knockroe, the Poulsen transatlantic station now building.

The lines of electric force are in general attached to the ground and follow it, as they do a wire in ordinary linear conduction. The resistance and dielectric constant of the ground are important factors in determining the distance to which it is possible to signal with any given transmitter and receiver. In general, the dielectric constant is the more important of the two, and the chief reason why it is more easy to transmit signals over water than land is that the dielectric constant of water is eighty, while for dry sand or rock it is only about five. Thus it is possible to transmit signals very much further over water with a given power than over land. The actual ratio of the distances is now calculable approximately in cases where the natures of the soil and subsoil are known.

6. It is now easy to determine with considerable accuracy, in fact within a few degrees, the direction from which a message is coming—a discovery which may in the near future become a great aid to navigation, since any two land stations within range of a ship will be able, by making simultaneous observations, to give their bearings, and thus to fix the actual position of the vessel. In these days of ever-increasing speeds it is becoming more and more essential that the shipmaster should be warned, when still a considerable distance away, of his approach to land. This has been done for some years by wireless telegraphy, but it is only recently that it has become possible to add to the warning a statement of the actual position of the ship at the time of sending.

7. The speed of transmission at moderate distances, and the reliability of a wireless connection, are now both as good as the same qualities in an ordinary land wire. A proof is given by the abolition of the post-office wire from Hunstanton to Skegness, England, since wireless stations have been erected, and the fact that a speed of ninety words per minute has been attained between these stations.

8. The means of preventing interference between neighboring stations have been developed to such good effect in the last few years that it is now possible, as experience shows, to construct apparatus which will respond only to waves which do not differ by more than about four per cent from the proper wave length for the station. An even greater sharpness in tuning has indeed been claimed by various workers, and may very probably have been obtained. A margin of four per cent is, however, sufficient to render possible the efficient working of a very large number of stations in a comparatively small area without interference. The actual wave lengths to be used by ships and shore stations have been fixed in some countries; and in all which are parties to the International Convention, the wave lengths from 600 to 1,600 metres are reserved for naval purposes; wave lengths below 600 metres being availale for short-distance stations, and those above 1,600 metres for long-range stations. The usual wave length for short-distance stations (*i. e.*, under 100 miles range) is about 400 metres. The German long-distance station at Nauen uses wave lengths of 2,000 metres; Poldhu (Marconi) of about 2,500 metres, and Clifden of about 4,300 metres.

Wireless Telephony—As, in the bridging of the Atlantic, wireless telegraphy takes its place this year as a factor in the long-distance communication of the world, one is suddenly made aware that a new agent has emerged from the darkness of the "experimental stage," and has arrived for good. The United States Navy has ordered twenty-eight sets of wireless telephones for use in communicating between warships. To those who have followed the experimental work which has been going on during the last eight years this development is not a matter of surprise, but merely a logical consequence, and now that the apparatus has reached so reliable a state that it is deemed suitable for use in warfare, it is practically certain that wireless telephony will make such rapid strides that, within the next five years, the development will be as great as that of wireless telegraphy in the past decade, and that in fact we shall have come in 1912 within measurable distance of opening up direct telephonic communication with every important city on the surface of the globe.

A vessel fitted with a wireless apparatus is practically never out of range of a commercial wireless telegraph station as long as it is within sixty or seventy miles of any part of the coast of the British Islands. The same is true of Europe, of the eastern coast of North America, from Labrador to Florida, and for the whole Gulf of Mexico and the West Indies. There are six or seven stations at various points along the east coast of South America, and ten or a dozen stations at points on the Pacific coast of South and North America. On the route to India and the East, there are points of communication after leaving the Channel which simply bristles with stations, at Ushant, Corunna, all round the Mediterranean, including even Tripoli, Tunis, and Algeria, Port Said, Port Tewfik, Sauger Island, India; Diamond Island, Burma; the Andaman Islands, the Philippines, Tsingtau, China; the Japanese coast, the Sandwich Islands, and Samoa. In addition to these stations, which are open for commercial work, there are, of course, many more which are intended for naval and lighthouse communications only, but which would be available in case of emergency to any vessel in distress.

The Machinery Club of the City of New York.

Great progress has been made in the organization of the Machinery Club of the City of New York, and it is expected that the new building, the Fulton Terminal Building, the twentieth and twenty-first floors and roof garden of which the club is to occupy, will be completed and ready for occupancy by May 1, 1908.

While the organization is to be called the Machinery Club, there will be a large representation of members in allied industries. The temporary office of the club is at 26 Cortlandt street, New York city. The officers are as follows: F. H. Stillman, president Watson-Stillman Company, president; R. C. McKinney, president Niles-Bement-Pond Company, vice-president; Walter L. Pierce, secretary Lidgerwood Manufacturing Company, treasurer; Theodore Waters, secretary.

The constitution and by-laws give the club a possible membership of 750 resident, 500 suburban and 1,000 non-resident. For resident members the initiation fee is $50, and the annual dues $50; for suburban members the initiation fee is $25 and the annual dues $25; for non-resident members the initiation fee is $10, and the annual dues $10. The honorary members include the president of the United States, the governor of the state of New York, the mayor of the city of New York, the commandant of the Brooklyn Navy Yard and the major-general commanding the Department of the East. The army and navy membership, which is unlimited, will not be required to pay an initiation fee, but will pay annual dues of $10. The board of governors has already passed upon a large membership list, including prominent men in the machinery and allied industries from all over the country.

THE PURIFICATION OF FEED-WATER.

BY CHARLES L. HUBBARD.

In a previous article[1] the effects of impure feed-water were briefly discussed and a few simple remedies pointed out for purifying the water after being introduced into the boiler and for removing the scale after it had already formed. In the present article methods for purifying the water before it is fed to the boilers will be taken up.

The impurities commonly found in feed water may be classed under three heads: Those causing the formation of scale; those having a corrosive action upon the plates and tubes, and foreign substances held in suspension, which either alone or in combination with an alkali may cause foaming.

The average heat conductivity of scale as shown by experiments is about three per cent of that of iron; hence, it is plain that more coal is required to generate a given amount of steam in a boiler containing scale than in a clean one. The following table shows approximately the increase in the amount of fuel required for different thicknesses of scale:

Thickness of Scale.	Increase in Fuel.
$\frac{1}{16}$ inch.	10 per cent.
$\frac{1}{8}$ "	15 "
$\frac{3}{16}$ "	20 "
$\frac{1}{4}$ "	25 "
$\frac{5}{16}$ "	30 "
$\frac{3}{8}$ "	35 "
$\frac{7}{16}$ "	40 "

The principal scale-forming substance are the carbonates and sulphates of lime and magnesia.

The corrosive impurities are comparatively rare but very destructive when present. They act on the interior surfaces of both the shell and crown sheets, and are especially destructive to tubes where they enter the headers. The action is rapid and not easily discovered, which makes it important to neutralize these elements before they enter the boiler.

Among the more important of the corrosive impurities are: Sulphuric acid, carbonic acid, sulphate of iron, and the chlorides of lime and magnesium.

Distilled water should also be classed as a corrosive.

Water may also contain various substances in suspension, such as oil, organic matter, mud, etc., and, in fact, all matter which is not in solution or in chemical combination with the water, comes under this head.

Although the various methods of purifying the feed-water may be carried on to a large extent in the boilers themselves, it is now quite general in the case of large plants to employ special apparatus for this purpose. Both mechanical and chemical treatment has been carried to a relatively high degree of success and the results obtained have shown a very satisfactory saving. The purifying and softening of the water are doing away with the mechanical washing and cleaning of the boilers, except at long intervals, resulting in a considerable saving in repairs and labor, which averages, in many cases, from fifty to seventy-five per cent. Frequent blowing off for the removal of scale and mud or sludge causes a decided loss both in heat and water.

The cost of purifying or softening plants, as it is commonly called, varies according to the type used and the size of the plant. The cost for plants below 1,000 horse-power is estimated from $4 to $5 per horse-power; for plants ranging from 1,000 to 2,000 horse-power, $3 to $4 per horse-power, and for plants of 2,000 to 5,000 horse-power the cost may run from $2 to $3 per horse-power or even less. In addition to the first cost of a softening plant there must be taken into consideration the depreciation and cost of chemicals. Where steel tanks are used the depreciation should not average more than about five per cent per year. Wooden tanks depreciate quite rapidly, and unless their cost of construction is much less than steel their use is not advisable. The chemicals used are not expensive, lime and soda being most commonly used.

The saving made by the use of a plant of this kind will, of course, vary, depending upon the size of the plant, the nature of the feed-water, etc. Reports of a number of tests show an economy of ten to fifteen per cent in the item of fuel. To this should be added the longer life of the boilers and the saving in repairs. Only approximate estimates of the total saving effected can, of course, be given, but sufficient data are available to show that this part of the equipment is of much importance in a modern steam plant.

The above estimate of costs of installation applies to complete outfits for the chemical purification of water; simple heaters or filters may be all that is necessary in some cases, which will, of course, reduce the cost proportionally.

The first step in any case is to have a chemical analysis made of the water in order to determine the kind and amount of the impurities present, after which an intelligent idea of the best method of treatment can be decided upon.

Boiler feed-water may be purified by any one or more of three ways: First, by heat; second, by filtering or mechanical means, and third, by the use of chemicals.

PURIFICATION BY HEAT.

This method is used when the water contains the carbonates of lime and magnesia in combination with carbonic acid, called bicarbonates, and also when the sulphates of lime and magnesia are present. These carbonates are only soluble in water containing carbonic acid, so that if the latter substance be removed the bicarbonates are changed to insoluble carbonates which are precipitated in the form of a soft sludge or mud which may be blown off from the bottom of the vessel containing the water. If this takes place in a boiler and the deposit is allowed to remain for any length of time the heat will bake it into the form of scale which must be removed by mechanical means. The carbonates themselves do not form a hard scale, but if mixed with other impurities such as the sulphates, oil, etc., they become much harder and more difficult to remove.

Again, if the precipitation is allowed to remain, the water may reabsorb carbonic acid gas from the atmosphere or other source, and the carbonates be again dissolved. Carbonic acid may be driven off by heating the water, or absorbed by the use of certain chemicals. Precipitation of lime and magnesia is practically complete at a temperature of 212 degrees.

The sulphates of lime and magnesia are soluble in cold water but become insoluble and are precipitated when the water reaches a temperature of about 300 degrees.

The precipitation of these impurities by heat is not a process which begins and is completed at the moment the water reaches the necessary temperature. The precipitation is gradual and extends over a considerable period, including temperatures both below and above 300 degrees, but in order to secure satisfactory results the temperature must be kept at or above this point. Here, as in the case of the carbonates, the precipitation is liable, under certain conditions, to be redissolved, so it is desirable to draw off the purified water in order to prevent this.

Of all scale-forming substances the sulphates are the most to be avoided because of the hardness and the tenacity with which the deposits adhere to the tubes and plates. The fact that the carbonates are precipitated at a temperature of 212 degrees, which is the temperature of steam at atmospheric pressure, and that the sul-

[1] ELECTRICAL REVIEW, vol. li, No. 2.

phates require a temperature of 300 degrees has led to the use of two types of heaters or purifiers. For the carbonates alone the usual form of open feed-water heater using exhaust steam may be used. It is also claimed that certain forms of closed heaters may be used for this purpose also. The objection to this type as a purifier is the comparatively small capacity and resulting rapidity of flow through the heater which is likely to carry the deposit into the boilers with the feed-water. Some makes are provided with special means for preventing this, such as settling chambers, filters, etc.

Open heaters, on the other hand, usually have a much larger volume for a given rating, which allows of a slower movement of the water in passing through them and therefore more opportunity for the separation of the precipitates. A common form of the open-exhaust heater and purifier was briefly described in a recent article by the writer. The water is usually supplied at the top where it falls in thin sheets over a series of screens or trays. It here becomes heated by direct contact with the steam and its temperature sufficiently raised to cause a precipitation of the carbonates. The water then passes through a filter, usually of coke or some similar substance, and is brought to comparative rest in a settling chamber before being drawn off by the pumps. In some cases the water falls from the trays directly into the settling chamber and then rises through the filter to a reservoir from which it is drawn by the pumps.

When the water contains the sulphates of lime and magnesia alone, or in addition to the bicarbonates, it must be heated to a higher temperature than can be obtained by the use of exhaust steam. In this case live-steam heaters must be used. Live-steam heaters, as the name indicates, use steam directly from the boilers and of a pressure not less than fifty pounds gauge, as this is the lowest pressure which will give the desired temperature.

Live-steam purifiers vary in construction the same as exhaust heaters. A typical form of the open type is shown in Fig. 1. This consists of a cylindrical shell having the interior fitted with removable pans. These pans are slightly dished and are made of thin steel plates riveted to cast-iron ends. The water to be purified enters the tee at B and is discharged into the centres of the two upper pans. From these it overflows into the second tier, then into the third and so on until the bottom of the heater is reached, after which it is drawn off at D and fed into the boiler. The purifier is ordinarily connected to the boiler by two lines of piping, one (A) for supplying steam and the other (D) for returning the feed-water by gravity to some point below the water line, the purifier being placed at the proper elevation to operate in this manner. A drain cock is provided at C for blowing out, as much sediment may be removed in this way. The live steam after entering comes in contact with the cooler water and heats it to a temperature sufficient to cause precipitation of the impurities; the carbonates being separated first and then the sulphates. The form of the pans is such that as the water overflows it adheres to the under side in a thin sheet. The precipitated impurities accumulate upon both sides of the pans and must be removed from time to time.

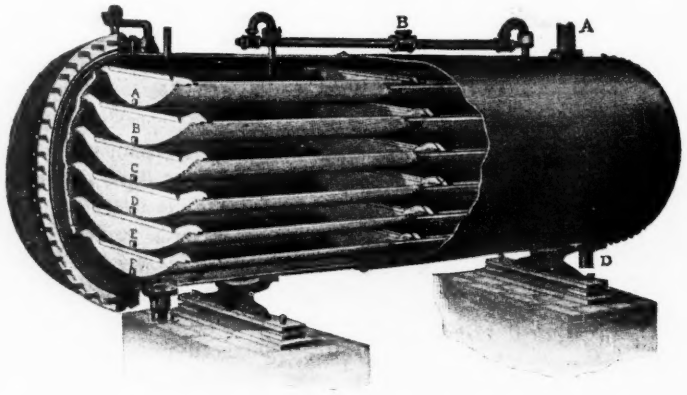


FIG. 1.—TYPICAL OPEN TYPE, LIVE-STEAM PURIFIER.

Owing to the greater intimacy of mixture of steam and water on the under side of the pans, the greater part of the deposit collects at this point, and it is not at all unusual to find a deposit of one and one-half to two inches in thickness on the underside while at the same time within the pans the thickness of the deposit is less than one-half inch.

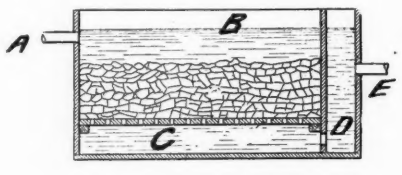


FIG. 2.—SIMPLE FILTER.

It is necessary for the best results that the purifier be of ample size, as already stated, because the precipitation of the sulphates is gradual and requires more or less time for completion. An approximate rule for proportioning a heater of this type is to allow one-half of a square foot of lime-catching surface for each boiler horse-power. When water is heated certain gases are given off which will accumulate in the purifier unless some special means are provided for their removal. This may be done by so arranging the piping that the feed pump may take its steam from the heating chamber when it is in use.

In deciding upon the type of heater to be used in any particular case, the first step is to obtain an analysis of the water. If only the bicarbonates are present, the exhaust heater is much to be preferred as a decided saving is made by utilizing the exhaust steam which would otherwise go to waste, unless the plant were run in connection with a heating system. If the sulphates are found, then a live-steam heater must be used if they are to be removed in this manner. It must be remembered, however, that heating the feed-water will only remove those impurities specifically mentioned in connection with this particular method of treatment; other substances require entirely different treatment, depending upon their composition.

PURIFICATION BY MECHANICAL MEANS.

This method of purification is employed only where the impurities are mechanically suspended in the water, such as mud, sand, oil, vegetable matter, etc., and may be done in three ways, according to the substances present, and the available space for apparatus, etc.

The methods commonly employed for this purpose are: Settling in large tanks, filtration, and skimming. To this may be added the removal of oil by separators.

In the case of small plants water containing earthy matter may be clarified by allowing it to stand for some time in settling tanks with little or no circulation, when the mud will be precipitated by gravity. Where this method is employed there should be at least two tanks or reservoirs so that while the feed is being

taken from one, the other is absolutely undisturbed until the first one is exhausted. The space occupied by the tanks and the time required for settling are the principal objections to this method and make it impractical for large plants. Again, water coming from swamps or streams draining large areas of forest often contains organic matter, such as finely divided vegetation, which will not settle and floats upon the surface; cases of this kind require a different treatment, such as filtering or skimming. There are several forms of simple filters which may be used for this purpose, one of which is shown in Fig. 2. This consists of a wooden tank having three compartments as shown. The main compartment has a perforated bottom which supports a bed of coke. The water enters at A and passes through the filter into compartment C, from which it passes into D and is then drawn by the pump through the pipe E. Particles of coke or sand which may be carried through the filter will collect in the bottom of chamber D.

Sometimes hay or excelsior is used in place of coke. To be effective and continuous in operation, two filters should be provided so that while one is being cleaned the other may be in use. It is found that the efficiency of this class of filters is rather low when the material is first renewed, but soon rises to a maximum as the deposit gathers in the interstices of the hay or coke. As the impurities continue to gather, the efficiency again decreases very slowly until a new charge is placed in the filter.

(To be continued.)

Award Cut from $132,000 to $1.

The award of $132,000 damages given to the Westinghouse Electric and Manufacturing Company in its suit against the Wagner Electric Manufacturing Company, of St. Louis, Mo., for alleged infringement of patent was cut to $1 by Judge Dyer in the Federal District Court on December 24.

The $132,000 award was made some time ago by Henry H. Denison, appointed special master by Judge Adams in 1904 to assess the damages. Judge Adams at that time held that the Wagner company had infringed on a patent on one portion of a certain electric transformer.

In his opinion Judge Dyer says that the master had assessed the damages on the profit on the sale of the entire transformer by the Wagner company, regardless of what percentage, if any, the part infringed upon bore to the whole.

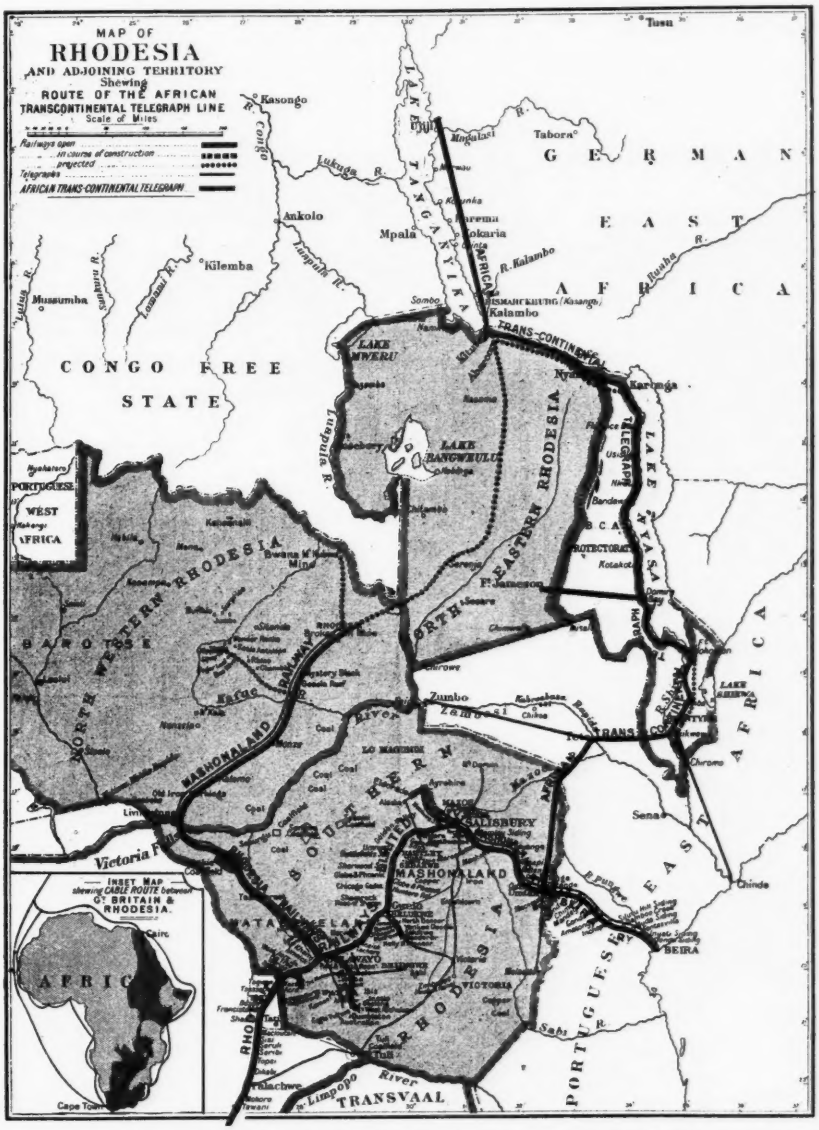
THE TELEGRAPH SYSTEM ACROSS AFRICA.

BY ALBERT H. BRIDGE.

When Cecil Rhodes was dreaming his dreams and drawing out his plans for development undertakings of wonderful proportions in Africa, he laid the foundations of many great works, the completion of which he never lived to see. In regard to most of these projects, it still has to be said that the time for their completion is not yet arrived and will not be for years to come.

It was Rhodes whom we believe Professor George Forbes was able to first interest in suggested schemes for the utilization of the Victoria Falls years and years ago, before electrical transmission was commercially practicable to anything like the distances that obtain to-day. Recent efforts to interest the British public financially in this matter have shown that it is anticipated that at some time or other a pretty substantial value will attach to this electrical concession.

Rhodes had as a very important work in connection with all his African development schemes, the establishment of a system of telegraphic communication from the Cape to Cairo. And, as was the case with so many of his ideas, he showed his belief in the promise of future success in helping in the development of the great continent that he handled it more as a personal scheme. He and his friends found the money, though the possibility of getting any return for many years was quite out of the question; and the doings of the African Transcontinental Telegraph Company, Limited, formed to construct the system, were directly under his



ROUTE OF THE AFRICAN TRANSCONTINENTAL TELEGRAPH LINE.

guidance. In May, 1898, he was saying: "They could not expect to make any profit until they got through to Cairo, for he did not think the local returns would pay."

Six years ago Rhodes died. He had made arrangements with the German government for the construction of the line through German East Africa, and of certain branch lines in that territory and for the working of such lines. Also for the other parts of the system he had made working arrangements with the British South Africa Company. But many things have happened since the work commenced which have had adverse effects upon the undertaking. For instance, the high submarine cable rates (in 1902 eight shillings and eleven pence per word) have been reduced to two shillings and six pence per word, and this reduction, of course, was a great obstacle in the way of raising further capital for a transcontinental line. The work has, however, been gradually going forward in spite of enormous difficulties, and in the accompanying map is given an idea of the present position. The total length of constructed line is 1,584 miles, made up of 1,389 miles of trunk line from Umtali to Ujiji, and two branch lines, one of 128 miles to Fort Jameson and one to Chiromo of sixty-seven miles.

Telegraph lines are being gradually brought down from Egypt and the north, and it is expected that in the course of time gaps now existing will be filled and a through line established. Further connections with coast towns such as Mombassa and Dar-es-Salam, and the gradual development of the whole of Central Africa, are expected to add local traffic, but it is admitted by those in control of the undertaking to-day that "a long time must elapse before it can be hoped to make the line self-supporting or profit-earning."

It will easily be gathered from a glance at the map indicating the route followed that the construction of the line has been a work of enormous difficulty. There are the natural difficulties presented by the diversified physical characteristics of the country traversed, which includes low-lying marsh lands, swamps, dense forests and jungle and mountainous regions intersected with deep and wide ravines. To all this we may add the difficulty of procuring and maintaining transport in a sparsely populated country; varied and trying climatic conditions along certain low-lying portions of the route, scarcity of water in some of the high altitudes, and damage done to the line as it progressed by elephants, giraffes and other wild animals.

The route of the existing line from Umtali up to Ujiji may be traced out as follows: From Umtali, in Southern Rhodesia, through Tete, in Portuguese East Africa, where it crosses the River Zambesi to Blantyre, in the British Central Africa Protectorate; thence along the western shore of Lake Nyasa through Domira Bay and Florence Bay to Karonga, where it leaves the lake and strikes a northwesterly course across the Tanganyika plateau, through Fort Hill, Nyala, Ikala, Fife and Abercorn to Kituta, which is on the extreme southeastern shore of Lake Tanganyika. From Kituta it proceeds in a northerly direction, roughly parallel with the lake, but a few miles to the east of it crosses the Kalambo river into German territory and passes through Bismarckburg to Ujiji. Here construction has ceased and a station for the receipt and transmission of telegrams has been opened.

The extreme difficulty of the territory north of Ujiji has led to proposals that for a certain distance connection shall be made here by means of wireless telegraphy. In German East Africa, indeed, there is a gap of some 320 miles, and there are shorter gaps at one or two other points between Cape Town and Cairo, and, while it is still intended that the whole thing shall ultimately be completed in accordance with Cecil Rhodes' plans, the Duke of Abercorn and his associates despair of bringing the undertaking through as a commercial enterprise.

It may be of interest to mention that in the will of Mr. Beit a sum of at least $6,000,000 was left to be devoted to improving means of communication in the Cape-Cairo region, and telegraph and telephone lines and wireless telegraphy are all specially mentioned. It has been suggested that part of that sum might reasonably be put toward the completion of this transcontinental telegraph system.

Electrical Supplies for the Navy Department.

The Bureau of Supplies and Accounts will open bids on January 14, at Washington, D. C., for the following electrical supplies: 3,000 feet of round ebonite, for delivery at the Naval Torpedo Station, Newport, R. I.; miscellaneous electrical supplies, Annapolis, Md.; fifty arc lamps, 400 non-watertight switches, New York, N. Y.

THE NEW GENERATORS AT THE LINCOLN WHARF STATION OF THE BOSTON ELEVATED.

TWO DIRECT-CURRENT UNITS WITH A COMBINED CAPACITY OF 8,000 KILOWATTS.

In the electric railway field one of the most interesting of recent installations is that made by the Boston Elevated Railway at its Lincoln Wharf station, where two Allis-Chalmers direct-current generators of 5,400 kilowatts combined capacity at normal load are now in operation, after one of the quickest deliveries on record for machines of this size.

The first of the generators, as shown in the accompanying illustration, was put in regular service October 23, which was eight days in advance of the date specified for delivery, notwithstanding the fact that there were unavoidable delays, aggregating more than thirty days, during the period of erection, as a result of other work in progress at the station. The second machine was placed in regular operation November 13, eighteen days prior to the time specified in the contract for the delivery of that unit.

On the second day following complete erection both machines were subjected to exhaustive tests under the direction of Messrs. Stone and Webster, consulting engineers for the Boston Elevated Railway Company. These tests consisted of thorough full-load and overload heat runs, as well as commutation tests under which the circuit-breaker was tripped at fifty per cent overload. These tests proved the machines to be well within the temperature guarantees, and the commutating conditions were equally satisfactory. Each machine is capable of carrying over 4,000 kilowatts, or, both together, over 8,000 kilowatts, with the same setting of brushes as at no load, which is evidence of their excellent commutating characteristics. It is also worthy of mention that the second machine was operated under a fifty per cent overload the second day after it was put into service, the first machine having been carrying its required load regularly from the time it was first put on the line until these tests were made.

These machines are so built as to satisfactorily meet the severe conditions of street railway service, which, at certain periods of the day, imposes large overloads; consequently they have been designed to endure sudden fluctuations in load of any degree from zero to the extreme limit of capacity, or *vice versa*, without shifting the brushes.

These generators, direct-connected to

vertical cross-compound engines, are of the multiple compound-wound type, designed for 575 volts at a speed of seventy-five revolutions per minute. The armature core of each is formed of punched steel laminations mounted on a cast-iron spider. The rings are composed of segments which are built up on the spider in such a way as to obtain the greatest possible strength. The armature construction is very open and ample air passages are provided throughout the core to insure thorough ventilation. The armature coils are made of drawn copper strip bent into shape in such a way as to be interchangeable on the same armature. The several conductors that are to go into the same slot, after being insulated individually

THE NEW 4,000-KILOWATT, 575-VOLT, DIRECT-CURRENT GENERATOR AT THE LINCOLN WHARF STATION OF THE BOSTON ELEVATED RAILWAY COMPANY, BOSTON, MASS.

with linen tape, are placed together and the necessary slot insulation is pressed on the coils by means of steam-heated presses.

The armature coils are held on the core by wooden wedges and the end connection held down by specially designed clamps, thus avoiding entirely the necessity of band wires. A brush oscillating device is provided, by means of which the brushes travel back and forth on the commutator in a direction parallel with the engine shaft, keeping the commutator in perfect condition and avoiding the usual wearing of grooves.

With additions made at the Lincoln Wharf, Harvard and Charlestown power stations of the Boston Elevated Railway, the total normal capacity of the system will reach approximately 50,000 kilowatts with ample provision for overloads. The work of laying out and constructing these improvements was placed in the hands of the Stone & Webster Engineering Corporation of Boston, in accordance with the recommendations made by them for a system, embodying the generation and distribution of power, which would provide both for present demands and any likely to be made within a reasonable time in the future. Direct-current generators, driven by steam engines, were ordered for the extensions so as to have them conform in general design to those already installed, thereby preserving uniformity; but at the same time care was taken to insure the building of machines fully equal in every way to the best designs evolved from modern engineering practice.

The Lincoln Wharf power station, where the new generators are installed, is the largest modern steam plant operated by the company, supplying current for surface and subway cars operated in the heart of the Boston business district as well as a large proportion of the power for the elevated system. As reconstructed, it will undoubtedly be one of the best plants of its kind to be found in any large city of the country.

Radium in Bulk.

The Academy of Science at Vienna, says the *Engineering Times*, London, has just made the largest quantity of radium yet produced—forty-six grains. Ten tons of uranium and pitchblende, given to the academy by the government from its mines in Bohemia, were used in its production. Its extraction cost $10,000. The academy will present a small fraction of the radium to Sir William Ramsay, the well-known English scientist, for experimental purposes. It will use part of it to test Professor Ramsay's theory regarding the effect of radium in producing transmutation of other elements.

The Colonna Double Electric Traction System.

To meet increased demands for traffic facilities, says *L'Électricien* (Paris), December 14, 1907, the first step usually is to increase as far as possible the number of individual cars operating on the line, but eventually a stage may be reached when it becomes impossible to run more individual units, so that increased facilities must be obtained by increasing the capacity of the number of traveling units. For this purpose the multiple-unit system has been adopted for street railway cars, so that trains may be built up when this seems desirable. This system is only applicable when new equipments are to be purchased or when a considerable expense is allowable for converting the old single-car system. To avoid this expense Enilio Colonna, chief engineer of the Circum-Vesuvian-Naples Railway, has devised a simple and inexpensive system which he has called the double-traction system. This was put into operation in the present year on the electric railway running from Naples to Vesuvius, and it is reported that it has given very good results. This road connects Naples and the valley of Pompeii. The total length of the line is forty-five miles, of which sixteen are electric and the remainder operated by steam. A section two and three-quarters miles long at Naples is common to both steam and electric trains. Over this are run daily seventy electric and thirty steam trains. To give the increased facilities required it became necessary to operate occasionally at least two cars, but this could not be done successfully without some means of communication between the two motormen. It was the object of the Colonna system to give each motorman an indicator showing him what the other is doing. This is done by running two parallel circuits through the cars. To each of these is connected an ammeter. One circuit of each car is connected to a shunt through which the current taken by the motors of that car passes, so that the ammeter on each car indicates the current taken by the motors on the other car. As it is not necessary that the readings of this instrument should be accurate, the long connection between meters and shunt is not objectionable. In operation, two cars are coupled together, each collecting current from the wire by its own trolley. The motorman on the front car is made responsible for the operation of the train, while the man in the rear car must follow the indications of his ammeter, which shows him what the other man is doing. Each sudden deflection in the needle of this instrument is an indication that the leading motorman has moved his controller one notch. When he passes from parallel to series grouping of the motors, the ammeter gives a very large deflection. The duties of the rear motorman then become merely to follow with his controller the indications of the ammeter; at the same time he can watch the trolley of the leading car, his own trolley being taken care of by the conductor of the train. Braking is accomplished by compressed air, though when necessary hand braking may be resorted to, in which case this duty devolves upon the rear motorman. The advantages of the system are the increased capacity of the trains, the increased security due to the provision of two trolleys and four motors instead of two. The cost of the additional equipment required to adapt the usual system to this method of operation is said to be not more than $30. It is said that two cars, when thus equipped, can be operated much more smoothly than two steam locomotives when coupled together.

Pennsylvania Street Railway Association Revived.

For the purpose of unifying action in subjects which may come before the state railroad commission, representatives of the various street railway companies in Pennsylvania have revived the Pennsylvania Street Railway Association. This organization was active a short time since in obtaining for the trolley companies the right of eminent domain and the privilege of carrying freight. In reviving the organization, it is explained, the purpose is solely to bring the representatives of the various companies together on subjects of public policy.

The board of officers, as now constituted, is as follows: President, F. B. Musser, Central Pennsylvania Traction Company, Harrisburg; first vice-president, R. P. Stevens, president Lehigh Valley Transit Company; second vice-president, Francis J. Torrance, Washington & Cannonsburg Railway Company; secretary, Charles H. Smith, Lebanon Valley Street Railway Company; treasurer, W. H. Lanius, York County Traction Company. The executive committee consists of Mr. Musser, Mr. Smith, Charles O. Kruger, Philadelphia; E. H. Davis, Williamsport, and John A. Rigg, Reading.

DISTRIBUTION OF LIGHT.[1]

BY OTTO FOELL.

The different papers heretofore presented before the Illuminating Engineering Society have dealt with subjects of vital interest in the art, yet I feel that not enough stress has been laid on the characteristics of the different illuminants now available for commercial application. I mean to say that not enough attention has been called to the character of the light, as far as its distribution is concerned and its applicability for certain classes of work. The essential feature in solving problems such as the illuminating engineer has to deal with is a complete knowledge of illuminants; that is, the illuminating engineer must be acquainted with the characteristics of the different light sources, so that he may be able successfully to take up problems that might be given to him for his consideration and advice.

The first requirement is to know the amount of light wanted in a particular case, and an illuminant should be chosen which will not only allow of uniformity in design throughout an installation, but will also meet conditions to best advantage from an illuminating engineering standpoint as well as from the point of operating expenses.

Generally, lamps are suspended from the ceiling, out of the direct vision of the eye. This is in accordance with an established principle of physiology, as the eye receives less strain when light is falling from above upon the surface which is to be illuminated.

The lamps must be placed properly with regard to distribution and candlepower; that is, they must not be placed indiscriminately, but their location must be chosen to obtain the desired effect. The distribution curve of a light source will give the illuminating engineer an idea of how to locate and space his lamps. It is natural, in large interiors, that the intensity of one lamp is reinforced by light falling from lamps in its immediate neighborhood. Taking this into consideration, the horizontal illumination in a certain plane is easily calculated. By moving the lamps one way or the other, that illumination may be secured which meets as nearly as possible the specified requirements.

The best way to study a distribution curve for artificial lighting is by comparison of the different illuminants. I shall therefore take up the characteristics of the newer light sources and compare their illuminating efficiency by calculating the illumination produced by each lamp in a horizontal plane. For example: A room, fifteen feet high, with ceiling outlets spaced twenty feet apart, is to be illuminated so that the intensity of illumination in a horizontal plane, three feet from the floor, is about two foot-candles. In making this comparison, I assume that the room is illuminated, first by four-glower Nernst lamps, second by five-ampere direct-current arc lamps, third by 250-watt "Gem" high-efficiency incandescent lamps, two lamps to the outlet. The distribution curves of these different lamps are shown in Fig. 1, the Nernst lamp being equipped with an eight-inch alabaster globe and the arc lamp with an opalescent inner globe and a clear outer globe.

The distribution curve for the arc lamp was taken from a report of the committee for investigating the photometric values of the arc lamp, of the National Electric Light Association, submitted May, 1903 (page 443 of Proceedings).

The distribution curve around the Gem lamps is taken from F. W. Willcox's paper read before the Ohio Electric Light Association, held at Put-in-Bay, Ohio, 1906.

The figures for Nernst lamps are results of tests made in the laboratory of the Nernst Lamp Company.

The illumination produced by two of each of these lamps, spaced as above, is given in Fig. 2, in which A represents

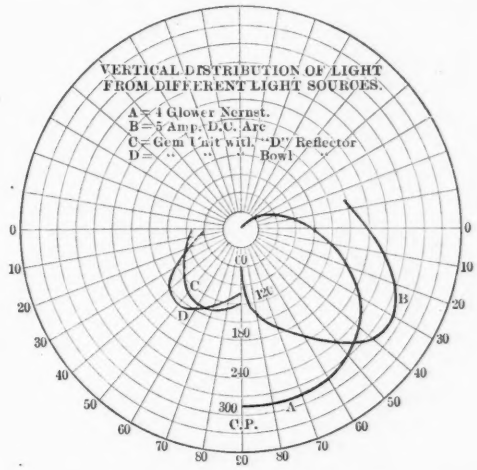

VERTICAL DISTRIBUTION OF LIGHT FROM DIFFERENT LIGHT SOURCES.
A = 4 Glower Nernst.
B = 5 Amp. D.C. Arc
C = Gem Unit with "D" Reflector
D = " " " Bowl "
C.P.

FIG. 1.—VERTICAL DISTRIBUTION OF LIGHT FROM DIFFERENT LIGHT SOURCES.

Nernst lamps; B. arc lamps; C, the Gem high-efficiency incandescent lamp equipped with bowl reflector, and D, the Gem high-efficiency incandescent lamp equipped with distributing reflector.

Referring to the Nernst lamp, it will be noted that the illumination produced by one lamp varies from about two foot-candles below the lamp to two-tenths of a foot-candle about twenty feet away from the lamp. The illumination secured from two of these lamps results in a maximum lighting intensity of 2.23 foot-candles directly beneath lamps and in a minimum illumination of 1.72 foot-candles between lamps; the average illumination secured by these lamps is 1.99 foot-candles, giving a total variation of 0.51 foot-candle, which is equal to 25.6 per cent of the average value of intensity.

Referring to the curves in Figs. 1 and

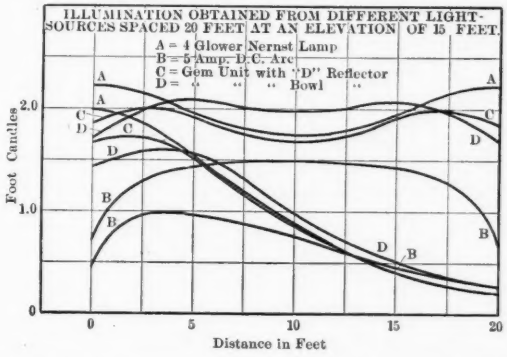

ILLUMINATION OBTAINED FROM DIFFERENT LIGHT-SOURCES SPACED 20 FEET AT AN ELEVATION OF 15 FEET.
A = 4 Glower Nernst Lamp
B = 5 Amp. D.C. Arc
C = Gem Unit with "D" Reflector
D = " " " Bowl "
Foot Candles
Distance in Feet

FIG. 2.—ILLUMINATION CURVES FROM VARIOUS LAMPS.

[1] Reprinted from the November issue of the Transactions of the Illuminating Engineering Society.

2, it is evident that all the light used for actual illumination is enclosed by a cone sixty degrees from the normal. The rest of the light is thrown in the upper zone and is practically wasted, serving to illuminate side walls and ceiling. It is a good practice to keep the light intensity on walls and ceiling low, say from 0.2 to

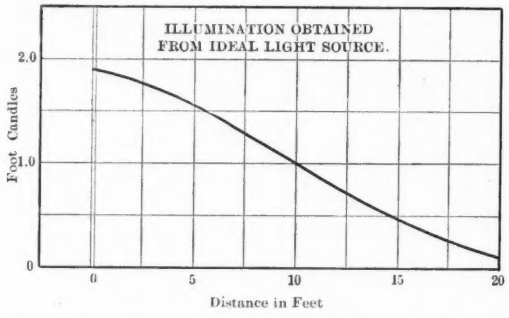


FIG. 3.—ILLUMINATION CURVE OF IDEAL LIGHT SOURCE.

0.3 foot-candle, which is enough to relieve utter darkness, and whereby spotted effects are avoided. Only in special cases is it desired to have a brighter intensity on the walls, for instance, to bring out pictures or other decorations.

That means that practically all the light which is thrown by illuminants in a space above thirty degrees below the horizontal can be of very low candlepower to effect a good illumination. I have endeavored to draw a curve showing the illumination from a lamp as it should be to produce a uniform illumination of two foot-candles under conditions mentioned. This curve is represented by Fig. 3. By comparison it will be seen that the intensity below and twenty feet away from the lamp should be about 0.1 foot-candle less than the normal four-glower lamp will give, while in the centre between the lamps the intensity is somewhat higher.

The distribution curve derived from this ideal illumination curve is given in Fig. 4. It will be seen from it that the light distribution should flatten out to some extent up to about forty-five degrees, where a maximum intensity occurs, and then the light intensity gradually diminishes until at about thirty degrees below the horizontal it is only about forty-six per cent of the intensity directly beneath the lamp.

The perfect distribution curve, which would give uniform illumination in a plane twelve feet below lamps spaced twenty feet apart, is as follows:

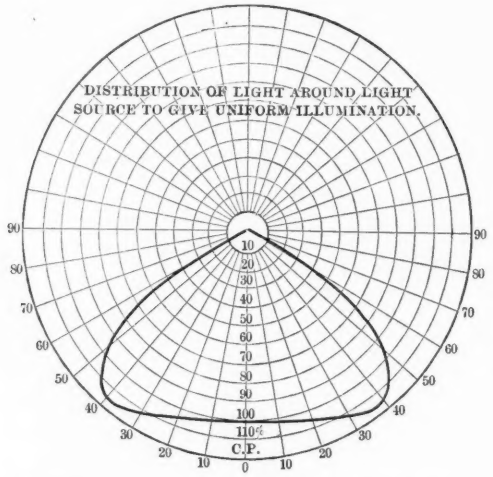


FIG. 4.—DISTRIBUTION CURVE OF IDEAL LIGHT SOURCE.

Degrees.	Per Cent.
0	100.0
10	100.0
20	105.2
30	111.0
40	116.5
50	97.0
60	46.0

As stated previously, however, this curve, although giving uniform illumination, is not ideal, inasmuch as it does not provide general illumination throughout the room. Some light should be given out in the proper zones to make the room appear cheerful. This might be accomplished by so designing a lamp that its distribution not only allows uniform illumination in a certain horizontal plane, but will also throw enough light into the upper zones to get the effect needed in lighting interiors.

Referring again to Fig. 2, curve B, which shows the illumination obtained from an arc lamp, it will be noted that the contrasts are very marked, the illuminating intensity varying from 0.42 foot-candle directly beneath the lamp to 1.50 foot-candles midway between the lamps. The mean intensity obtained from these two arcs is 1.36 foot-candles. The total variation is 1.08 foot-candles, or seventy-nine per cent of the average illuminating intensity. The illumination obtained is far less than the required two foot-candles.

The figures for arc lamps are results on lamps without reflectors, as in almost every case arc lamps are used that way; but usually with an opalescent outer globe instead of the clear outer globe. While the opalescent outer globe might give a somewhat more diffused light than is obtained from the clear outer globe, yet the light intensity is less than that stated above.

An inspection of the distribution curve will clearly indicate that a very large amount of light is wasted by being thrown in a zone where it is not needed, and which makes a room appear poorly lighted by contrast, although the intensity of light in a certain plane comes up to the required amount. This effect has been pointed out by Preston S. Millar in a paper which he presented before the first annual convention of the Society. He stated that in case of indirect lighting, double the amount of light is required for reading than is needed when the room is illuminated directly.

From the foregoing, I have come to the conclusion that the arc lamp is not very well suited for interior illumination, the character of its distribution being such that the light can not be utilized to the best advantage from an illuminating engineering standpoint and because of the cost of operation.

To obtain the same effect as produced by a four-glower Nernst lamp, with high-efficiency incandescent lamps, two lamps had to be placed to the outlet. The distribution from the incandescent lamps with bowl and distributing type reflectors resulted in an illumination pretty near that of the Nernst lamp.

Referring to the curve in Fig. 2, giving

the illumination from Gem lamps with bowl reflectors, we see that the minimum is 1.67 foot-candles directly beneath the lamp and 2.07 foot-candles five feet away from the lamp. These figures clearly indicate that the light between lamps equipped with the bowl reflector is greater than below the lamps, when lamps are installed as is customary. It has been claimed for this distribution that it practically affords uniform illumination. This is true only where lamps are spaced very far apart and at a certain height. In that case, however, it is evident that the intensity of light is naturally low and not suited for many plans. If a certain intensity of light is required which will enable a person to work, lamps must be spaced closer together, and then the result will be a higher illumination between the lamps than directly beneath them. It is evident from this that the efficiency of a lamp having a distribution such as that given out by any incandescent lamp equipped with a bowl reflector is not the best, since the light decreases inversely as the square of the distance, and it is natural that a large amount of light must be thrown sidewise which, if directed in a different way, might result in a more uniform illumination and a more economical installation in the number of lamps installed and for a given illuminating intensity.

The illumination from the Gem lamp, with distributing type of reflector, resembles fairly well that secured from the four-glower Nernst lamp, the only difference being that the maximum intensity of illumination is not directly beneath the lamp, but about three feet away from it. Other examples might be mentioned.

The spacing of the lamps will change the illuminating intensity more or less, according to the character of their distribution. That is, the closer the lamps are spaced, the less uniform will be the illuminating intensity; the further the lamps are spaced apart, the less will be the light intensity; while the character of the distribution determines the uniformity. For an ideal illumination, the distribution curve around a lamp changes with the height at which the lamps are suspended, and with the distance the lamps are spaced. That is, no distribution curve can be determined which will give uniform illumination on all horizontal planes.

The examples given above are guides to what can be accomplished with a proper light distribution, and they show what is wasted from improper characteristics.

I want to point out very forcibly that it is a downward distribution which gives the most efficient lighting, as far as operating expense is concerned, and which also gives the most uniform lighting, by the application of such auxiliary devices as may be necessary to obtain that distribution curve which can not be obtained from certain lamps by virtue of their construction.

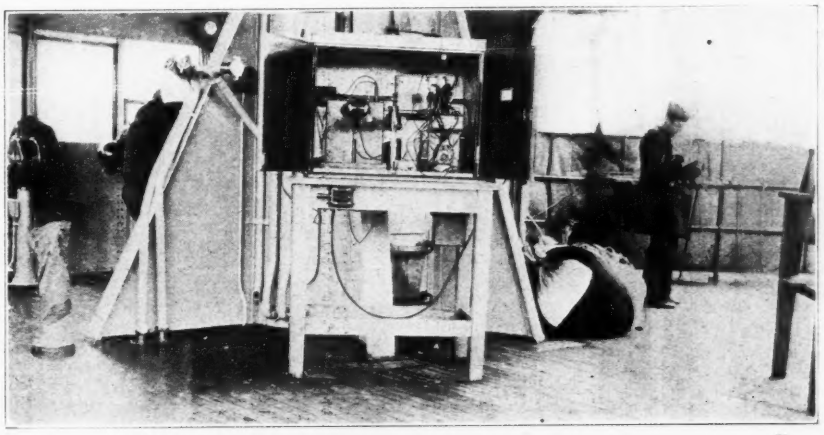
This consideration brings to mind again the question of what is the proper way of rating and comparing illuminants. It is an established custom that the rating of any illuminant shall be according to its mean spherical candle-power. That is, by the total flux of light measured all over the surface of a sphere, with the light source in its centre. However, I regard such a rating as wrong in principle, inasmuch as it does not give an idea of the value of a lamp for practical illumination, and, furthermore, such a rating is wrong, generally speaking, because a light source may be of high spherical candle-power, yet when equipped with accessories to direct the light where needed it is much lower in efficiency than a lamp which may give, by virtue of its design and construction, a better distribution.

I have pointed out in the above examples what an ideal distribution curve should be. All that is required is light in a zone, say twenty degrees below the horizontal, and for this reason the value of a light should be determined and compared on the basis of mean zonular candle-power, the zone to extend up to twenty degrees below the horizontal.

A man who provides illumination is not buying efficiency, but is buying light, and that lamp will appeal to him as the best which gives him the best illumination at the least expense to himself. Inasmuch as such a lamp must have a downward distribution, the only fair way to compare illuminants is to consider the illuminating power, and that is very well expressed by establishing a rating of mean zonular candle-power, or better, of mean hemispherical candle-power. This is in line with the proceedings of the German Electrical Society, which some time ago adopted such rating as the proper basis of comparing lamps.

Radiotelephone Apparatus on Shipboard.

The accompanying illustration shows the de Forest radiotelephone apparatus as installed on the bridge of the U. S. S. Rhode Island. This picture is typical of the installations on each of the sixteen battleships and torpedo-boat destroyers which are now *en route* to the Pacific under Admiral Evans.



De Forest Radiotelephone on Bridge of the United States Ship Rhode Island.

The apparatus for the entire twenty-eight installations was constructed, installed and tested within six weeks, a remarkable performance considering the many unforeseen difficulties attendant on a work of such novelty. During the preliminary trials at Fortress Monroe, under the personal supervision of Dr. de Forest, messages were exchanged up to a distance of fifteen miles, and when the fleet sailed from Fortress Monroe communication was maintained up to thirty miles. Subsequent reports state that the apparatus was fulfilling expectations, and that the various orders between the vessels of the fleet were being transmitted by this means.

The United States Signal Corps has two de Forest radiotelephones installed, one at Fortress Monroe and the other on the mine-planter tug Ringgold; this tug tows the target in target practice, and it is the purpose of the signal corps to report immediately the results of the shots as observed on the Ringgold during target practice.

A NOVEL SINGLE-PHASE MOTOR INSTALLATION.

AN INTERESTING EXAMPLE OF THE ADAPTATION OF SINGLE-PHASE MOTORS TO THE DRIVING OF TEXTILE MACHINERY.

An interesting example of the application of single-phase motor to the operation of textile machinery, and one that is worthy of notice, is found in the factory of the Ayvad Manufacturing Company, of Hoboken, N. J. The product of this company is the well-known "water wings," a device used by bathers and beginners in swimming to assist in floating the body. The style of drive used throughout is what is commonly known as the "group drive," in which a number of machines are driven by a motor from countershafts. The electrical installation, consisting of nine single-phase induction motors, of a total capacity of seventy-five and one-half horse-power, was furnished by the General Electric Company. The type of motor used is one recently developed by the above company for operation on single-phase circuits and is known as the Form "KG."

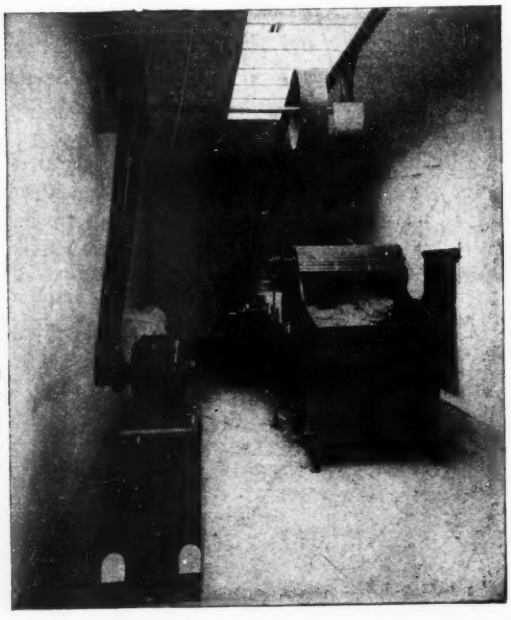


FIG. 1.—PICKER DRIVEN BY SEVEN AND ONE-HALF HORSE-POWER INDUCTION MOTOR, IN FACTORY OF AYVAD MANUFACTURING COMPANY, HOBOKEN, N. J.

FIG. 2.—DRAWING FRAMES DRIVEN BY TEN HORSE-POWER, 220-VOLT, SINGLE-PHASE INDUCTION MOTORS.

The conditions influencing the final decision in favor of the single-phase alternating-current motors were that the factory was located in a part of the city supplied with single-phase alternating current for lighting and that the motors used must operate without affecting the lights on the same circuit; also, that all sparking of motors must be entirely eliminated. This last condition is one peculiar to textile mills, for in the early stages of cloth manufacture the cotton is in a highly inflammable condition, and the least spark might start a disastrous fire. A thorough investigation of the single-phase motor finally selected satisfied the manufacturers that all conditions were met in the design of the motor, all commutators and brushes being eliminated.

Until this year the practice of the Ayvad Manufacturing Company was to buy the cloth used in the manufacture of their product from textile mills, their factory converting the fabric into the finished product. Since it was impossible to properly inspect every yard of the cloth for flaws, there often resulted a product of inferior quality. Delays in shipment and in transportation further added to the difficulties of manufacture.

To avoid all delays and to insure a good, uniform quality of cloth, a complete textile equipment, from picker to loom, was installed. The textile equipment now enables them to operate the factory during the entire year, where heretofore only six months' operation was sufficient to supply the demand. Any excess of cloth produced forms a profitable side line. The factory when in full operation will furnish employment for about sixty persons

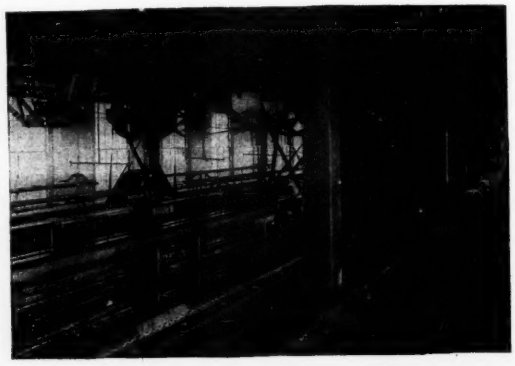


FIG. 3.—SPINNING FRAMES DRIVEN BY TEN HORSE-POWER, SINGLE-PHASE INDUCTION MOTORS.

FIG. 4.—LOOMS DRIVEN BY TEN HORSE-POWER, SINGLE-PHASE INDUCTION MOTOR.

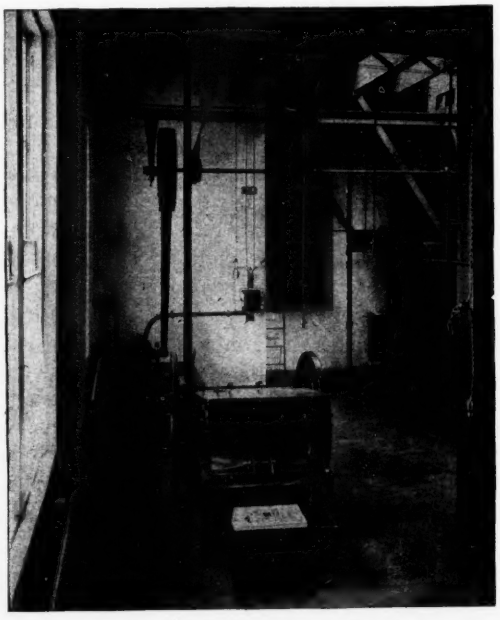


FIG. 5.—PONY CYLINDER PRESS DRIVEN BY FIVE HORSE-POWER, SINGLE-PHASE INDUCTION MOTOR.

and will require an average of about 5,000 pounds of cotton weekly.

The different views shown herewith will give some idea of the adaptability of the single-phase motor to the driving of textile machinery.

The view of the "picker" room, as shown in Fig. 1, gives the method of countershaft connection to the motor. The power required for running the "picker" is about seven and one-half horse-power. The "picker" room was built as an annex to the main factory, and to provide sufficient light for working, a skylight was placed in the roof and the walls painted white.

The two ten-horse-power motors shown in Fig. 2 drive separate line shafting, from which are driven the carding machines, drawing frames, roving machines and fly frames.

In this same room the lines from the power circuit enter through the necessary switches, protective devices, measuring instruments, etc.

In Fig. 3 is shown a view of the spinning room and two of the three ten-horse-power motors driving twelve spinning frames, with a total capacity of 3,000 spindles. The third motor, not shown in the view, drives a "spooler" and one warp machine. All motors are installed on platforms suspended from the ceiling and drive the spinning frames through countershafting. Sheet-iron arches over the passageways protect employés from accidental contact with the belts. In the background of the picture may be seen the starting boxes for the motors. All the starting boxes are installed on slate panels with a backing of sheet asbestos.

In the view of the loom room, shown in Fig. 4, may be seen the ten-horse-power motor driving the looms. It was calculated that about seven and one-half horse-power would be required to drive the looms and a "slasher" not shown in the view. This leaves an ample margin in additional horse-power should it be found necessary to install other looms.

The five-horse-power motor shown in Fig. 5 drives a "pony" cylinder press, also line shafting from which are driven cutting presses and other special machines used in shaping and finishing the "wings." The printing press is used for printing the design on the cloth and also for printing advertising pamphlets and circulars. On this same floor a three-horse-power motor drives a group of special sewing machines.

The entire plant is well equipped, roomy and modern in every respect. While an excellent example of the methods in which single-phase motors may be advantageously applied to the operation of textile mills, it also brings forward to central station managers the possibilities existing in territories reached by single-phase distribution lines.

It is expected that the adoption of the electric drive will result in a maximum output with minimum operating and maintenance expenses, as has been proved in similar cases, to say nothing of the additional advantages of cleanliness and flexibility that go far toward making popular this method of machine drive.

The Industrial Outlook.

"It is daily becoming more apparent," said President W. H. Whiteside, of the Allis-Chalmers Company, in a recent interview, "that the general business of the country has not been so seriously injured by the recent sudden financial depression as the public has been inclined to believe. And I am firmly of the opinion that the thing now most necessary is to loosen the chains of conservatism and give courage an opportunity to assert itself and make advances consistent with the generally prosperous conditions and well-distributed resources of the country. As the production and use of basic machinery, such as prime movers for the generation of power, is a very potent and leading factor in our commercial activities, very naturally it is one of the first lines of business to be affected when the pendulum swings from optimism to pessimism, and likewise the first to feel the effect when the change in sentiment again manifests itself. The number and character of inquiries which our offices, located in the principal commercial centres of the country, have recently been receiving convincingly demonstrate a return of confidence, and bear evidence that not only a diversified but a large volume of business will be offering ere the middle of the first quarter of 1908 has been passed.

"Until within a few months manufacturers everywhere in the United States found themselves urgently in need of increased facilities for carrying on their own business, and when they are again called upon to supply the normal demands of business, and to replenish stocks in the hands of jobbers and retailers, many of which are now nearing the point of depletion, they must, of necessity, again work their plants to the full of their present capacities, and add increased machinery equipment, the plans for which in numerous instances are already well matured.

"The railroads of the country, whose policy of retrenchment has continued for approximately a year, notwithstanding the largest offerings of traffic, with resultant increased earnings, in their entire history, must shortly be compelled to again enter the market and make large expenditures for renewals, including train equipment, steel rails and general supplies. This, coupled with the approaching need for the renewal of stocks of metal employed in all branches of industry, which, through shutdowns of furnaces and smelters and the continued use of iron, steel and copper for current consumption, have now been lowered very near to the minimum, and giving due consideration to the large balance now in our favor in our commerce with foreign nations, and to the well-distributed revenues from our exceptionally large agricultural products, can not fail to create an early demand for new machinery and auxiliary equipment.

"The outlook is, therefore, distinctly encouraging."

American Institute of Electrical Engineers.

The next meeting of the American Institute of Electrical Engineers will be held in the auditorium of the Engineering Societies Building, No. 33 West Thirty-ninth street, New York city, Friday, January 10, 1908, at 8 P. M.

The following papers will be presented for discussion:

1. "The New Haven System of Single-Phase Distribution, with Special Reference to Sectionalization." By W. S. Murray, electrical engineer, New York, New Haven & Hartford Railroad.

2. "A Single-Phase Railway Motor." By E. F. Alexanderson, electrical engineer, General Electric Company, Schenectady, N. Y.

A special meeting of the Institute will be held in the auditorium of the Engineering Societies Building, Friday, January 24, 1908, at 8 P. M.

At this meeting the following papers will be presented for discussion:

1. "Electrical Engineering Education." By Charles P. Steinmetz, chief electrician, General Electric Company, Schenectady, N. Y.

2. "The Best Engineering Education." By Charles F. Scott, consulting engineer, Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.

THE ELECTRIFICATION OF THE SWEDISH STATE RAILWAYS.[1]

THE REPORT OF THE CHIEF OF THE ELECTRICAL DEPARTMENT.

That Sweden is in earnest as regards the adoption of electric traction on a considerable portion of the state railways has been made evident by the recent purchase by the government of various waterfalls; nor can this action cause any surprise when one realizes that the aggregate power of the Swedish waterfalls is estimated at 3,773,000 horse-power, after the requisite regulation has been effected. Although some other countries are ahead of Sweden as regards the electrification of their railways at the present moment, there is reason to believe that the latter country will soon make a decided and comprehensive move toward overtaking them, and an elaborate and exhaustive plan has been officially prepared for this purpose. At the same time the electrical working of the small section which was set aside for tests has given most satisfactory and encouraging results.

These tests, which have attracted a considerable amount of attention, have just been brought to a close; and it is officially admitted that the results must be looked upon as absolutely satisfactory, so that the electrification of a large portion of the Swedish state railways is likely to be taken in hand without any delay. The Swedish Riksdag having voted a sum toward this experimental working, a start was made in 1905; but it was not until 1906 that the working of the experimental line began in earnest under the auspices of Robert Dahlander, the chief of the electrical department of the state railways. The two main issues of the test-working were to ascertain whether electric traction was practical and suitable; and, secondly, its economic results as compared with steam. The reply to the first question was arrived at readily and unhesitatingly in favor of electric traction, nor are the pecuniary advantages of the latter system inconsiderable. Apart from this, great stress is laid upon the fact that the Swedish state railways, when electrically worked, will be no longer under the necessity of importing foreign coal. Mr. Dahlander soon arrived at the conclusion that the only system which was likely to answer was the single-phase current with high tension. There was not very much practical experience elsewhere to fall back upon as regards this system, for it was only introduced in Germany in the year 1902. In spite of predictions to the contrary, the system, however, answered remarkably well. The electric traction was put to the test on two lines: Stockholm-Järfoa and Tomteboda-Vörtan, and a temporary power station of 540-horse-power capacity was erected at Tomteboda. The motors put on came from different works, German and American. The working has been perfectly rational, and on a sufficiently large scale to form the basis of exact and exhaustive calculations, and everything points to the attainment of most satisfactory results when the system is adopted over a larger area.

In the following paragraphs is given an abstract of the report prepared by Mr. Dahlander, as the basis of a scheme for the whole country, with two exceptions.

The decision in question affects all the railways south of Bollnäs (some 150 miles north of Stockholm), with the exception of the three following lines: Laxa-Charlottenburg, Orebro-Svarta, and Gothenburg-Stromstad, which sections for sundry reasons have not been included in the report. The large system of railways that comes under the scheme will, it is proposed, be supplied with electricity from five power stations at the Karsefors, the Trollhättan (both on or near the West Coast), the Motala, the Hammarby (having a central position), and the Alfkarleby Fall (near the East Coast and more northerly than the rest). The number of transformer stations is about thirty-five. It is distinctly pointed out that as the electric working is more economical with a large traffic, the calculations based upon the present available statistics do not compare favorably with what may be the state of affairs some years hence, when the electrification may have been brought about.

The traffic mileage of the railways included in the present scheme amounts in the aggregate to some 1,300 miles, of which there are 1,230 miles single line, seventy miles double line, besides 440 miles of sidings. Owing to the increase of the traffic it will, no doubt, be necessary to build more double lines and to increase the mileage of the sidings. This latter increase is put at forty-five per cent, and it is taken that the lines on which an increase of sixty per cent in the traffic (which, according to recent experiences, may be expected by the year 1920) makes the increase necessary, carry an annual traffic of 300,000 carriage-axle kilometres per kilometre of rail, and would have been transformed into double lines by the year 1920. On this basis the lines Stockholm-Gothenburg, Stockholm-Bollnäs, Katrineholm-Malmö and Hallsberg-Frövi will have been made double-tracked at that time. This surmise, it is pointed out, makes the calculations look less flattering, inasmuch as the cost of the electric conductors is only slightly increased through increased traffic, while the second road means an increase of cost under that head of forty per cent. A larger calculated increase in the traffic of, say, 100 per cent or more would also make the calculations look better than one of sixty per cent.

The electric conductors are intended to carry a pressure of 50,000 volts in the feeders from the power stations and 15,000 volts in the contact wires. The electric wires will be attached to wooden poles placed at a distance of eighty-three feet on the single-rail lines, alternately on the right and the left side of the railway. The number of poles per mile will consequently be sixty-four for single lines and 128 for double lines; at sidings one pole will, as a rule, serve for two wires, making an average of forty per mile, this making a total of 106,000 poles with the lines as in 1905, and 162,000 in 1920. The contact wire is so attached that should any fault arise in bracket or insulator, it can stand without one alternate pole while the repair is going on. The sectional area of the contact wire will be 130,000 circular mils for all principal railway lines, and 100,000 circular mils for sidings. The height of the contact wire above the surface of the rails is to be twenty feet, except in tunnels and under bridges, where the height will have to be reduced. The calculated cost includes the raising of bridges and of tunnels to at least eighteen feet. The contact wires have double insulators.

The power wires along the railway lines are to be attached to the same poles as the contact wires, but higher up, so that the latter can be repaired without interfering with the former's transmission of electric current. This arrangement will necessitate comparatively high poles, say forty feet, on the ordinary railway lines, and thirty-three feet on the sidings. Between the waterfalls and the state railways there are to be two lines of power wires, independent of each other, on supports of iron fixed in concrete. The distance between these is put at 366 feet, and every ninth support will be stronger than the others.

All the transmission lines are calculated to be constructed with as complete reserve arrangements as possible. From all the power stations except the one at Hammarby the transmission lines will proceed in

[1] From *Engineering*, London, December 13.

two directions, and, as already stated, each with two independent sets of wires. From the point where these wires reach the railway double power lines will be installed, one on each side of the railway. These power lines will feed the transformer stations, of which there are to be thirty-seven, lying along the railways at a distance of some thirty miles from each other. These transformer stations in their turn will feed the contact wires in two directions, so that each point, under ordinary circumstances, receives current from two sides. The contact wires on a few shorter sections, which only receive current from one side, will have instead two feeding wires, coupled parallel with the contact line, one on each side of the railway. Each of the four power-transmitting wires running along the railway will be able to be automatically switched off between each two transformer stations. These four 0.6-inch square wires will also go to those parts of the railway which are furthest away from the power station, and which consequently adjoin the area of the next power station, in order to enable the one power station to help the other by taking over the working of the nearest portion.

The wires along the railway are so calculated that the normal maximum decrease of pressure, even with the most unfavorable train arrangements, shall not exceed fifteen per cent, inclusive of four per cent drop in the transformers of the substations. These calculations are based upon the highest possible number of trains and of weight per train, and the most unfavorable position of the trains.

In explanation of the calculation of costs, some particulars are given in the report. The interest is put at 3.8 per cent. The price of copper was very high at the time, and has been put at thirty cents a pound for ordinary hard-drawn wire, and thirty-one cents a pound for contact wire; ten per cent has been added to the weights for various losses. The depreciation has been put at 0.7 per cent for all other copper than that of the contact lines, where the figure is 2.5 per cent; the figure for the insulators has been put at six per cent. The life of the poles has been put at twenty years; although the life of poles impregnated with oil, according to the experience of the German state telegraphs, exceeds that period. On account of the doubling of the tracks, or from other causes, all poles are expected to be removed in ten years' time. The depreciation figure for heavy painted ironwork is put at two per cent, and 2.50 per cent for smaller ironwork. The cost of men at the transformer stations is calculated at about $2,200 per station, and close upon $87.50 per mile of such power line as does not run along the line. The cost of the transformer stations themselves, without the transformers, is put at about $16,250 (about eight per cent dearer in 1920). The maximum effect of the transformers is placed at 1,500 kilovolt-amperes, and the cost of each at $41,300; the number of transformers for each station varies from two to five, one being intended as reserve.

The electric wires are, as already stated, calculated for a pressure of 50,000 volts in the power wires and 15,000 volts in the contact wires. The adoption of a third-wire system with 2 × 20,000 volts in the power lines, and 20,000 volts in the contact lines has been suggested, in which case the transformer stations could be avoided and the contact wire divided into sections, which were fed alternately from the one or the other power line. Instead of transformer stations, pressure-dividing transformers would have to be installed at certain places in order to reduce the drop of pressure in the rails. In this case considerably more copper would be required, but, on the other hand, so much would be saved by the transformer stations that this system would effect a saving of some $24,300 to $29,200 a year; but, failing exhaustive information about the latter, the former system has been adhered to in the calculations.

The cost of removal of telephone wires, and possible alteration of telegraph wires, is put at about $630 per mile of railway line; and a sum of $267,000 has been put aside for sundry expenses, such as new telephone wires, crossing rivers, etc.; a further sum of $464,000 has been reserved for management of work and general expenses.

Water-power stations are proposed, built at the Karsefors Fall, in the River Lagan; Trollhättan Fall, in the Göta river; Motala river, between Norrby Lake and Roxen; Hammarby Fall, in the River Jäslean, and Alfkarleby Fall, in the Dalar river. These falls now all belong to the state, and the power calculations are subject to the requisite water regulations. The different power stations are intended to supply the following railway sections with power:

The Karsefors station is to provide power for all state railways south of Falkenberg and Stockaryd. The scheme also embraces a peat power station in the province of Smaland, although the latter is not required for the present-day traffic. From the Karsefors station it is proposed to carry power lines to Laholm and Ousby.

The Trollhättan station will supply power to the Falkenberg-Gothenburg-Laxa line, the Falköping-Nässjö and the Sköfde-Karlsborg line; power wires will be carried to Gothenburg and Falköping.

The Motala station will provide power for the Stockaryd-Gnesta and the Mjölby-Hallsberg line; power lines are to be carried to Linköping and Karlsby.

The Hammarby Fall station will supply power to the Laxa-Katrineholm and the Hallsberg-Frövi line, with a power line to Ervalla. It is proposed to construct an auxiliary peat power station for the last two stations in the vicinity of Katrineholm, but this will not be required until 1920.

The Alfkarleby Fall is intended for the Gnesta-Stockholm-Bollnäs section, and the Krylbo-Frövi line, besides the Kilafors-Stugsund line, by means of power lines to Storvik and Upsala. A special power line will be carried between Potebro and Saltskog, so as to obtain a direct high-tension connection without having to take it through Stockholm.

The calculated average speed per hour is thirty-seven and one-half miles for express trains, twenty-eight miles for passenger trains, and twenty miles for freight trains, which is considerably faster than the present actual speeds. With reference to varying power required, it would seem that fifty per cent would cover the maximum excess power above the average power; an exception is made for the Alfkarleby station, where a maximum excess of sixty per cent is reckoned on; the heaviest passenger traffic is at Christmas time, and the heaviest freight traffic generally in March. The maximum power requirement for train service is calculated according to the average effect of a maximum day with the most unfavorable train combinations. The requirements of electricity for lighting and warming were calculated on the basis of a two-axle passenger car with sixteen ten-candle lamps, requiring 0.6 kilowatt, and a double-truck with thirty-five ten-candle lamps requiring 1.25 kilowatts; for the lighting of the stations an arc lamp is calculated for each 2,000 feet of sidings. The energy required for heating the train is put at thirty kilowatt-hours for first heating of a double-truck and eight to ten kilowatts constant for maintaining the heat while running; these figures should be halved for two-axle cars.

The cost of the water-power stations and their working has been based upon

the calculations of an eminent Stockholm firm of engineers, with some additions, at Motala, of $267,000 for compensation for flooded lands and for a portion of the water regulation, and at Hammarby power station of some $53,500. The rates and depreciation have also been raised, *viz.:* to eight per cent for machinery and instruments, 2.5 per cent for water-controlling works, two per cent for buildings, and 0.7 per cent of purchase moneys, compensations, etc. At Alfkarleby a value of about $670,000 has been put on the natural power which will be exploited for the railways, and this sum is to be amortized at 0.7 per cent, like other similar values. The cost for the power from Trollhättan has been estimated according to calculations based upon the actual cost of power for the state, with the value of the natural power added. The peat power stations are intended to assist the water-power stations on the comparatively few days of maximum traffic, and to form a reserve for those stations in cases of an insufficiency of water, etc. The peat power stations, according to the plan, will be fitted with steam-turbine generators, each station having a capacity of 4,000 horse-power. As these stations, however, are likely to be very little used by the railways, power can, no doubt, be sold to other users, although this has not been reckoned in the calculations. The depreciation has been put at six per cent for machinery, and two per cent for buildings. The calculated cost of fuel, reckoned upon twenty days' full working, is based on 5.5 pounds peat per horse-power-hour, and a price of $2.64 for a ton of peat. For unforeseen expenses a sum of $380,000 has been added as an aggregate for all the power stations.

The aggregate cost, based upon the traffic of the year 1905, amounts to:

Electric lines, transformer stations, etc	$9,900,000
Power stations	6,480,000
Total	$16,380,000

With sixty per cent larger traffic, which is expected by the year 1920, the figures will be:

Electric lines, transformer stations, etc	$12,700,000
Power stations	7,400,000
Total	$20,100,000

The expenditure, based on the traffic of the year 1905, amounts to:

On electric lines, transformer stations, staff of men, etc	$735,000
At power stations	605,000
Management	27,000
Total	$1,367,000

The annual expenditure, based on an increase of sixty per cent in traffic, as expected in 1920, amounts to:

On electric lines, transformer stations, staff of men, etc	$925,000
At the power stations	765,000
Management	32,400
Total	$1,722,400

Further, the cost of electric locomotives has to be considered. In the year 1905 there were on the lines in question fifty-seven express, 335 passenger and freight, and eighty-eight local and shunting locomotives. With electric traction a smaller number of locomotives will be required, partly because the cleaning of boilers will not necessitate so many days off (now, as a rule, every tenth day), partly because steam locomotives, on account of the cleaning they require, can not be put on the road again immediately after a long run, which electric locomotives, as far as present experiences show, can. Finally, passenger and freight locomotives can take each other's place, whereby the number of reserve engines can be reduced, which is of importance, inasmuch as the maximum freight and passenger traffic do not set in simultaneously. The calculated expenditure for electric locomotives, in consequence, only embraces (for present traffic):

45 express locomotives at $22,900 each	$1,030,000
260 passenger and goods locomotives, $24,300	6,320,000
80 smaller locomotives at $13,500	1,080,000
Total	$8,430,000

The cost of steam locomotives of the same actual capacity amounts to:

57 express locomotives at $14,500	$827,000
335 goods and passenger locomotives at $18,000	6,020,000
88 smaller locomotives at $10,300	907,000
Total	$7,754,000

The difference in cost between electric and steam locomotives is thus some $617,000 in favor of the latter. As the electrification will be brought about by degrees, steam locomotives which have become superfluous on electrified lines, or sections, can be used elsewhere, and are thus likely to be able to serve their time. Consequently the increased locomotive cost by electrification may be put at eight per cent of the difference in cost, or about $49,000.

With reference to the savings entailed by the introduction of electric traction, there is, in the first instance, the question of fuel. During the year 1905 the cost of fuel for locomotives on the lines in question amounted to $960,000. Prices for coal, however, ruled very low that year, and were 9.4 per cent beneath the average of the preceding ten years; it will therefore be more correct to take the average of this decade—$990,000. The transport of coal is calculated to cost the state railways $77,800 annually. Then there is the loss of interest on coal, which has been put at $32,000, so that the total annual saving by discarding fuel may be placed at about $1,100,000.

The saving on lubricating and cleaning may be put at $27,700 per year, which is half the cost of oil, tallow, etc., for 1905.

The cost of locomotive repairs on the lines in question amounted, for the year 1905, to $463,000. On electric locomotives there are, of course, no boiler repairs, nor are there any for cylinders, etc. The repairs of framework, axle bearings, etc., will easily, it is estimated, be kept within twenty per cent of the total repair cost of steam locomotives. On the debit side comes the fresh expense of maintaining the electric equipment, which may be put at three per cent of its cost. The electric equipment is calculated at two-thirds of the entire cost of locomotives, or $8,430,000.

The repair account for electric locomotives consequently amounts to:

For the mechanical parts	$92,500
For the electrical parts	169,000
Total	$261,500

The saving, according to the above calculations, would consequently amount to $202,000 for the year 1905.

The work of the locomotive personnel will, it is considered, be much facilitated by the introduction of electric traction. The cost under this head for the year 1905 amounted to $545,000, on which a saving of twenty per cent may be reckoned, which amounts to $109,000 per annum.

The pay to men in charge of pumps, coal-stores, and cleaners amounted for the year 1905 on the lines in question to $228,000, about equally divided between pumpmen and coalmen on the one side, and cleaners on the other. Even supposing that the pumping-stations are maintained after the introduction of electric traction, so that steam locomotives can be used if required, the wages to pumpmen and coalmen will, on the whole, be done away with; the pumping machinery might be electrically driven if wanted. The saving on pumpmen and coalmen is therefore put at $108,000. The number of locomotive cleaners can, of course, also be materially reduced. At present thirty per cent of the cleaners attend to the boilers, so a saving of thirty per cent, or $33,200, may safely be assumed under this head. These two items make a saving of about $141,200 a year.

The cost for locomotive sheds and pumping stations amounted during 1905 to $71,000. Under this head (pumping stations) a saving of thirty-five per cent is assumed, which amounts to about $25,000.

The aggregate savings by the introduction of electric traction are consequently assumed to be as under:

Fuel, cost	$990,000
Fuel, transport	77,800
Interest on coal in stock	32,000
Lubricant, etc	27,700
Repairs	200,000
Pay to locomotive staff	116,500
Pay to pumpers, etc	136,000
Pumping stations, etc	24,300
Total	$1,604,300

The saving on the locomotive service does not quite exhaust the list of savings, for a saving in lighting of cars of $24,000, and in lighting stations of $53,500, must also be taken into account. This, in consequence, brings up the saving in working to about $1,681,800 per annum.

For safety's sake fifty steam locomotives are to be kept as a reserve; and, supposing each of these locomotives runs 6,200 miles a year, they will entail an expenditure of about $48,600, which, with eight per cent for depreciation, makes an aggregate of about $110,000. This amount should consequently be added to the cost of the electric traction already specified. Further, interest and depreciation on the difference in cost between electric and steam locomotives and the cost of several parts peculiar to electric locomotives should be added. The former item is about $48,600, the latter is put at $36,400, the three items amounting in the aggregate to some $194,000. This brings up the cost of electric traction to about $1,580,000, but as the saving in abandoning steam locomotives has been shown to amount to $1,700,000, there is a balance in favor of electric traction of $120,000 per annum.

This figure represents the actual saving which the introduction of electric traction on the lines in question would mean, supposing the traffic remained stationary at the figures of the year 1905. A material increase must, however, be expected before the introduction of electric traction is completed. The cost of lines and power stations, with sixty per cent increase in traffic (1920) as already specified, has been put at $1,722,400 per annum. To this must be added the amortizing of the difference between the difference of cost of electric and steam locomotives, and the expense of coal, etc.; both these items have been raised with the same percentage as the traffic—*viz.*, sixty per cent, to respectively $79,200 and $58,700. The fifty steam locomotives have been maintained as reserve. The total figure will thus comprise $1,723,000, $79,200, $58,700, and $110,000, and come out at about $1,969,900. By adopting superheated steam the expense of working the steam locomotives can no doubt be reduced, so that the increase in cost of fuel can be put at only thirty-five per cent, instead of sixty per cent, while the other expenses increase in proportion with the traffic. The saving in the pay to pumpmen and coalmen, as well as for the lighting of the stations, has only been put at twenty per cent.

The saving for 1920 should thus be:

$1.35 ×	$1,105,000 =	$1,500,000
1.60 ×	431,000 =	690,000
1.20 ×	162,000 =	194,000
Total		$2,384,000

The difference in favor of electric traction by the year 1920 should consequently, it is calculated, be $2,384,000, less $1,980,000, which makes it $404,000 a year; in itself a handsome figure, which an increase in the price of coal would further enhance.

The calculations and particulars set forth above only apply to the state railways of southern Sweden, but as northern Sweden is singularly rich in water power, and as the traffic also in those parts is likely materially to increase, it is probable that—if the soundness of the calculations be confirmed—electric traction will, in due course, be adopted for the greater portion of the Swedish state railways. The line most likely to be first transformed is the important Stockholm-Gothenburg line.

Mexican Electric Projects.

At the rapid rate at which applications are being made, says the Boston *Transcript*, to the Federal Government for concessions by persons who have planned to install hydroelectric plants it will not be many years until the electric power development of Mexico will have exceeded that of any other country. Already some of the largest hydroelectric plants in the world have been installed there, notably that of the Canadian syndicate at Necaxa, which supplies that city, Puebla, El Oro and other places with electric power and lights. This syndicate has expended many millions of dollars in installing its plant and in constructing its long transmission lines and substations.

The available water power of the rivers throughout Mexico is being rapidly acquired by persons who contemplate the early installation of hydroelectric plants. In many instances these plants are to furnish power and lights for mines. In other cases they are to provide electric lights for towns. According to official advices received by the Federal Department of Interior, or Fomento, as it is called, the latest hydroelectric projects number twenty-five.

The installation of these numerous plants will require the use of a large amount of electrical machinery, much of which will be purchased in the United States, although Germany is doing a business in this line with Mexico which shows a large increase during the last year.

Rafael R. Arizpe, who was appointed by the Federal Government to make an inspection of the mechanical, hydraulic and electric works which have been constructed at Necaxa under the concession which was granted the Mexican Light and Power Company, recently submitted his report, which recommended that the government approve the work that has been done up to this time. The report was accepted by the government and official approval of the Necaxa plant was given. This formal approval gives the Mexican Light and Power Company full right to go ahead with its plans for the development of the power from the Necaxa and Tenango rivers, the concession for which was granted by the government on May 20, 1903, and was to become finally effective when the company should have installed works for the development of a certain amount of horsepower within a period of ten years from the date the concession was granted. The company has developed many thousands more horse-power than the requirements of the concession called for. A second concession, which covers several other rivers and involves the installation of several more large hydroelectric plants and the building of long transmission lines, was granted the company on June 15, 1906. The company is given fifteen years in which to complete its installations under the second concession.

Bernard MacDonald, an American, who has made a large fortune in mines in Mexico, is at the head of a company which has been formed for the purpose of installing a hydroelectric plant, or rather, a series of plants, in Northern Mexico. The company is named the Monterey Hydroelectric Company and it is planned to expend about $3,000,000 in installing hydroelectric plants on the Pilon river, near Montemorelos, state of Nuevo Leon. These plants will be three in number and a total of more than 12,000 horse-power will be generated. The water will be brought from the river through a tunnel eight miles long. The power will be transmitted to Monterey, Montemorelos, Linares and other towns of that region. The details of the plans for the big enterprise have been worked out and construction work will be started soon. Associated with Mr. MacDonald in the project are his brother, M. E. MacDonald, and a number of other Americans. The MacDonald brothers have made their headquarters at Guanajuato, Mexico, for a number of years.

THE RELUCTANCE OF THE AIR-GAP IN DYNAMO MACHINES.[1]

BY THOS. F. WALL.

There appears to be, so far as the author is aware, a scarcity of experimental data concerning the reluctance of the air-gap in dynamo machines with slotted armatures, and also as to the distribution of the flux over the surface of the pole-shoes and on the surfaces of the teeth themselves. Although the estimation of the reluctance of the gap is of great importance in the design of machines, the only experiments which appear to have been made in this direction are those of Hele-Shaw, Hay and Powell.[2] In the following pages the results of some measurements are described which were carried out this year in the Electrotechnical Institute, Karlsruhe.

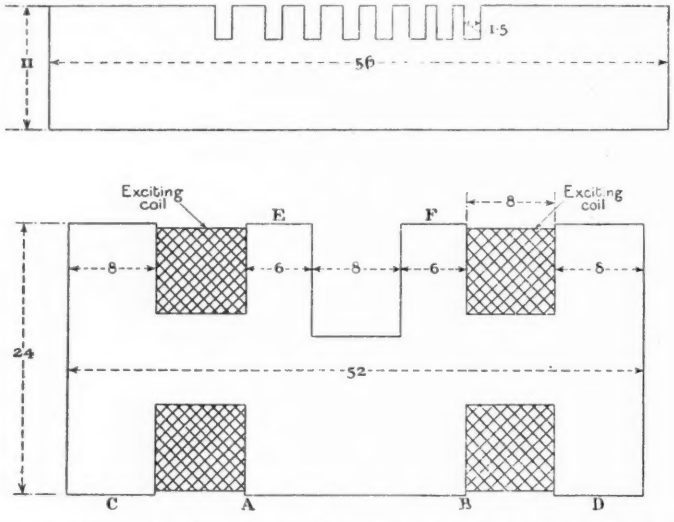


FIG. 1.—EXPERIMENTAL MODEL FOR THE DETERMINATION OF THE FLUX DISTRIBUTION ON THE FLANKS AND SURFACES OF THE TEETH.

Dimensions in centimetres. Width of apparatus perpendicular to plane of paper = 11 centimetres.

These measurements have been employed to find the increase of the reluctance of the air-gap due to slotting the armature, and a comparison has been made of the values so found with those given by the methods generally used.

The apparatus was specially designed and made for these experiments, and is shown in Fig. 1. It was made in two parts, one part built up of iron laminations and containing the exciting coils, which will hereafter be referred to as the pole piece, the other part being simply a rectangular piece of laminated iron slotted on one side and smooth on the opposite side. This part will be referred to as the armature in what follows. All the slots were of the same dimensions, namely, 1.5 centimetres, and the teeth were made so that two were one centimetre wide, two 1.5 centimetres and 1.53 centimetres wide respectively, two 1.95 centimetres and 1.96 centimetres wide respectively, and one three centimetres wide. These parts were used together in the following way: When it was desired to measure the flux distribution on the pole piece when used with the slotted armature the latter was placed on the pole piece with the slot opposite the smooth portion A B. The air-gap could be varied at will by inserting plates between the armature and pole piece at C and D, each plate being two millimetres thick. When the flux distribution on the smooth surface of the armature was to be found the pole piece was turned over and the armature laid on it with the smooth side opposite the large polar projections. The air-gap could be varied as before.

FIG. 2.—SEARCH COIL.

In order to explore the field a search-coil was made of two millimetres width and having two turns. The sides of this coil were laid in grooves in a strip of vulcanite, and flush with the surface (see Fig. 2). By this arrangement the coil could be placed on the surface of the pole piece or the surface of the armature as desired, and by means of ballistic measurements the distribution of flux could be completely examined. The ballistic throw was measured when the circuit of the exciting coils was broken, this having been found to give the most satisfactory results. The galvanometer had a period of swing of about thirty-five seconds.

It was found that if the current in the exciting coils was large enough to cause much temperature rise in the iron, the change in permeability thus produced was sufficient to affect the throw, and the measurements had to be taken in every case when the iron had assumed a steady temperature.

I—EXPERIMENTS ON THE SURFACE AND FLANKS OF THE POLAR PROJECTIONS.

Experiment 1—This experiment was made to examine the flux distribution on the surface and flanks of the polar projections E F (Fig. 1), and also the corresponding flux distribution on the smooth surface of the armature. Although in practice pole tips would never be so sharp as in this case, but would be more or less rounded off, yet these polar projections may be looked upon as large teeth, and the curves obtained will be similar to those for teeth of more normal dimensions, but having the same ratios of width of tooth to width of slot and width of tooth to length of gap.

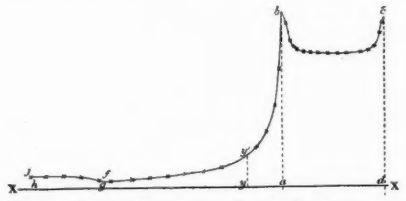


FIG. 3.—CURVE SHOWING FLUX DISTRIBUTION ON POLE-FACE AND FLANK.

Air-gap = 1 centimetre. Width of pole face = 5.8 centimetres. Length of pole perpendicular to plane of paper = 11 centimetres. Average flux density over pole surface = 16,000 lines per square centimetre.

In this experiment:

Length of the air-gap = 1 cm.
Width of polar projection = 5.8 cm.

$$\text{Ratio } \frac{\text{width of pole}}{\text{length of air-gap}} = 5.8 \text{ cms.}$$

Fig. 3 shows the flux distribution curve on the surface and flank of one of the polar projections. The characteristic feature of this curve is the large peak at each pole tip. This indicates, of course, that the flux is much denser at the tip than at the middle of the pole surface. The explanation of the existence of these tips may be looked for in the fact that the flux tends to spread out on the armature surface in order to take up the path of least reluctance, and thus concentrates on the

[1] A paper read before the Manchester section of the Institution of Electrical Engineers of Great Britain, December, 1907.

[2] *Journal of the Institution of Electrical Engineers*, vol. xxxiv, p. 21, 1905.

pole surface at the tips. The case is, in fact, similar to that of electrified metallic plates separated by an air-gap, the density of the electric charge being greatest at the corners or edges. The peak on the tip adjacent to the existing coil is somewhat different to the peak at the other tip owing to the presence of this coil and the consequent unsymmetry of the arrangement.

Fig. 4 shows the curve of flux distribution on the smooth surface of the armature. This curve has the shape usually shown, and it is seen that the flux density at a point immediately opposite the pole-tip is much smaller than it is at a point under the middle of the pole. The point at which the flux density falls off rapidly appears to be at a distance equal to the air-gap, from the point just under the pole-tip.

The average flux density at the surface of the pole was about 16,000 lines per square centimetre, and the ratio of the maximum density at the pole-tip to the density at the middle of the pole was found, by measuring the curve, to be 1.32.

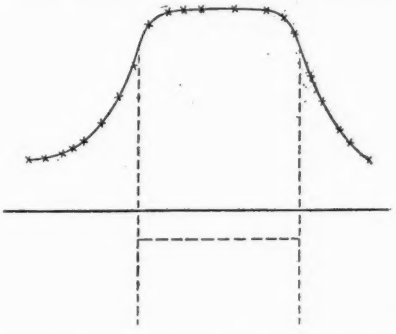


FIG. 4.—CURVE SHOWING FLUX DISTRIBUTION ON SURFACE OF ARMATURE.

Air-gap = 1 centimetre. Length of armature perpendicular to plane of paper = 11 centimetres. Average flux density under the pole, about 16,000 lines per square centimetre.

Experiment 2—This experiment was similar to the previous one, except that the air-gap was smaller and the flux density much less. In this case:

Air-gap = 2.3 mm.

Ratio $\frac{\text{width of pole}}{\text{length of air-gap}} = 25.2$

The flux density under the pole was approximately 5,000 lines per cm.^{2}

The curve for the distribution of flux on the polar face shows again the peaks at the pole-tips, although they are now very much smaller than was the case in Experiment 1, with a large air-gap. This indicates that the peaks are dependent on the size of the gap, or, more correctly, on the ratio of slot width to gap.

The curve of flux distribution on the armature surface has the usual shape, and the point at which the flux density begins to rapidly fall off is at a distance equal to about twice the air-gap from the point on the armature just opposite a pole-tip.

It is interesting to note from these curves that with a large gap the maximum flux density on the pole-face is greater than the maximum flux density on the armature surface. With a small gap the maximum flux density on the pole-face is about equal to the maximum of flux density on the armature surface. The curves also show how much flux leaks out of the flanks of the pole and also how much passes from the root of the gap between the poles.

In Fig. 3 the part *a b c d* gives the flux issuing from the polar surface, the part *a b f g* represents the flux issuing from the pole flank, and the part *f g h j* shows the flux issuing from half of the root of the gap between the polar projections. Thus, the ordinates of the curve *b f* give the flux density at the various points of the flank measured from X X as abscissa. For

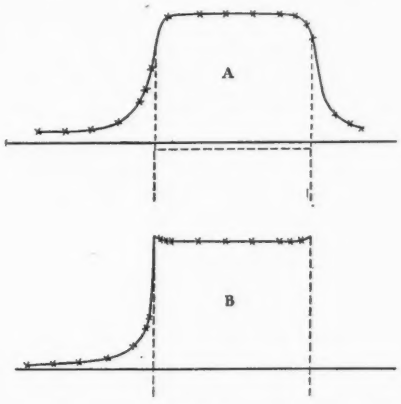


FIG. 5.

Air-gap = 2.3 millimetres. Flux density (average) at the surface of the pole, about 5,000 lines per square centimetre. Width of pole face = 5.8 centimetres. Length of pole perpendicular to plane of paper = 11 centimetres.

example, at a point two centimetres down the pole flank the flux density is measured by the ordinate *y y'* where *a y* = 2 centimetres. This method of plotting the curves has been adopted throughout.

II—EXPERIMENTS WITH THE SLOTTED SIDE OF THE ARMATURE AND SMOOTH SIDE OF THE POLE PIECE.

In these experiments the flux distribution on the surface of the pole piece due to the armature teeth was ascertained for various values of the air-gap, and also the complete flux distribution over the surfaces and flanks of the teeth. This was done, as in the previous experiment, by placing the search coil at various parts of the surfaces of the armature and pole piece.

Experiment 1:

Air-gap = 2.3 mm.

Ratio $\frac{\text{slot}}{\text{gap}} = 6.5$

Ratio $\frac{\text{tooth width}}{\text{gap}}$ for the various teeth = 4.35, 6.51, 6.66, 8.48, 8.52, 13.05

Average flux density on the tooth surface, 5,000 lines per cm.^{2}

The curve in Fig. 6 shows the flux distribution on the pole surface. It is seen that the density varies very considerably at points under the teeth and under the slots. This really gives the case of the flux distribution on the surface of the pole in a direct-current machine when the slot and gap relations are as shown. As the teeth pass across the surface of the pole-shoe this wave moves with them and corresponding eddy currents are set up. It is noticeable that if the tooth is too narrow relatively to the air-gap the flux wave never becomes flat under the tooth.

The points at which the curve of flux density on the pole-piece surface begins rapidly to diminish is approximately at distances from the tips of the teeth about equal to the width of the gap. The curves for the pole-piece surface have been measured, and the results are as follows:

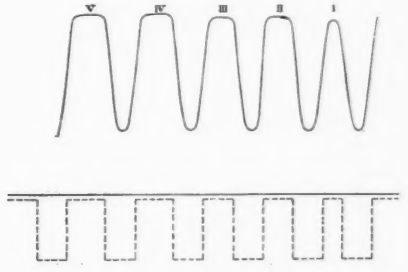


FIG. 6.—FLUX DISTRIBUTION CURVE ON THE SMOOTH SURFACE OF POLE PIECE.

Air-gap = 2.3 millimetres. Average flux density under a tooth, about 5,000 lines per square centimetre.

Curve I—Area = 1,460; mean height = 57.1; maximum height = 88.5; minimum height = 31.5.

Curve II—Area = 1,927; mean height = 66.3; maximum height = 90.5; minimum height = 31.8.

Curve III—Area = 2,004; mean height = 64.5; maximum height = 90.2; minimum height = 32.0.

Curve IV—Area = 2,356; mean height = 67.3; maximum height = 91.0; minimum height = 31.8.

In Fig. 7 the flux distribution on the surfaces and flanks of the several teeth has been plotted—the air-gap and flux density being the same as for the curves of Fig. 6. These curves in Fig. 7 have been plotted in precisely the same way as in Fig. 3, and the method has been already fully explained.

The characteristic feature of these curves is the high flux density at the tooth tips. Thus in Curve I, Fig. 7, the density at the tooth tip is greater than the density at the middle of the tooth surface by about ten per cent. Moreover, the flux density at a point at the middle of the tooth surface is greater than at the point just opposite on the pole piece, and the same features can be observed for all the teeth. The curves also show to what extent the flux leaks out from the flanks of the teeth into the pole piece.

Curve I—Area = 1,535; ratio, flux density at tip to flux density at middle of

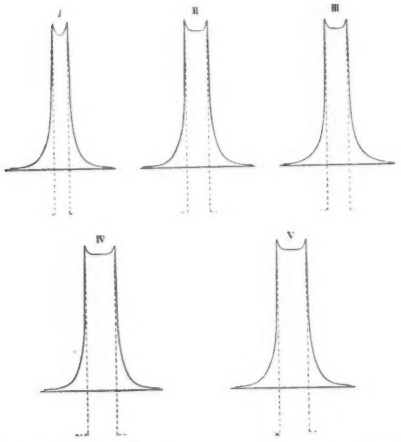


FIG. 7.—FLUX DISTRIBUTION ON THE SURFACES AND FLANKS OF THE TEETH.

Air-gap = 2.3 millimetres.

tooth surface = 1.11; minimum height for the surface of the tooth = 90.6.

Curve II—Area = 1,944; ratio, flux density at tip to flux density at middle of tooth surface = 1.08; minimum height for the surface of the tooth = 91.8.

Curve III—Area = 2,019; ratio, flux density at tip to flux density at middle of tooth surface = 1.07; minimum height for the surface of the tooth = 91.8.

Curve IV—Area = 2,366; ratio, flux density at tip to flux density at middle of tooth surface = 1.07; minimum height for the surface of the tooth = 90.2.

Experiment 2:

Air-gap = 5.3 mm.

Ratio $\frac{\text{slot}}{\text{gap}} = 2.83$

Ratio $\frac{\text{tooth width}}{\text{gap}}$ for the various teeth = 1.89, 2.83, 2.89, 3.68, 3.7, 5.66

Average flux density on the tooth surface = 6,600 lines per cm.²

In Fig. 8 the flux distribution curves are given for the surface of the pole piece under these conditions. It will be noticed that the flat tops of the curves have almost disappeared and the distribution takes a definite wave shape. Further, the fluctuations of the flux at any point on the pole-piece surface are much less than was the case with a smaller air-gap.

The following gives the details of the several curves:

Curve I—Area = 1,820; mean height

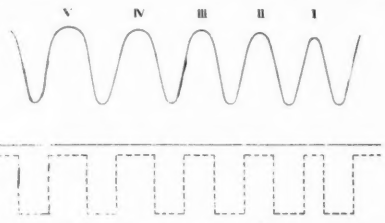


FIG. 8.—FLUX DISTRIBUTION CURVE ON THE SMOOTH SURFACE OF THE POLE PIECE.

Air-gap = 5.3 millimetres. Average flux density at surface of a tooth = 6,600 lines per square centimetre.

= 71.3; maximum height = 93.8; minimum height = 54.5.

Curve II—Area = 2,218; mean height = 73.9; maximum height = 94.35; minimum height = 54.5.

Curve III—Area = 2,278; mean height = 76.0; maximum height = 94.6; minimum height = 55.0.

Curve IV—Area = 2,630; mean height = 76.3; maximum height = 94.5; minimum height = 55.0.

Fig. 9 shows the flux distribution on the surfaces and flanks of the various teeth for the same gap and flux density as for the curve in Fig. 8. In this case the peaks of flux concentration at the teeth tips are more marked than they were for the smaller air-gap.

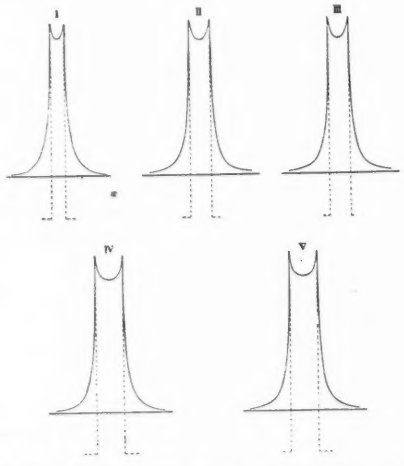


FIG. 9.—FLUX DISTRIBUTION ON THE SURFACES AND FLANKS OF THE TEETH.

Air-gap = 5.3 millimetres. Average flux density on surface of a tooth, about 6,600 lines per square centimetre.

Curve I—Area = 1,783; ratio, flux density at tip to flux density at middle of tooth surface = 1.11; minimum height for the surface of the tooth = 98.8.

Curve II—Area = 2,295; ratio, flux density at tip to flux density at middle of tooth surface = 1.15; minimum height for the surface of the tooth = 97.5.

Curve III—Area = 2,183; ratio, flux density at tip to flux density at middle of tooth surface = 1.16; minimum height for the surface of the tooth = 97.1.

Curve IV—Area = 2,636; ratio, flux density at tip to flux density at middle of tooth surface = 1.18; minimum height for the surface of the tooth = 95.5.

Experiment 3:

Air-gap = 7.3 mm.

Ratio $\frac{\text{slot}}{\text{gap}} = 2.05$

Ratio $\frac{\text{tooth width}}{\text{gap}}$ for the various teeth = 1.37, 2.05, 2.09, 2.67, 2.68, 4.1

Average flux density on the tooth surface ≃ 5,000 lines per cm.²

Fig. 10 shows the curve of flux distribution on the pole-piece surface, and it is seen that the effect of increasing the air-gap has been again to diminish the fluctuation of the field.

The measurements of the several curves are as follows:

Curve I—Area = 1,525; mean height

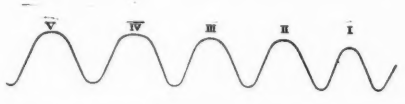


FIG. 10.—CURVE SHOWING FLUX DISTRIBUTION ON SMOOTH SURFACE OF POLE PIECE.

Air-gap = 7.3 millimetres. Average flux density at surface of a tooth, about 5,000 lines per square centimetre.

= 62.3; maximum height = 73.0; minimum height = 53.0.

Curve II—Area = 1,846; mean height = 61.5; maximum height = 72.7; minimum height = 53.0.

Curve III—Area = 1,973; mean height = 64.6; maximum height = 74.2; minimum height = 53.5.

Curve IV—Area = 2,309; mean height = 67.0; maximum height = 74.5; minimum height = 54.0.

The flux distribution on the surfaces and flanks of the teeth for the above air-gap and density is shown in Fig. 11. The effect of the larger gap is to further increase the relative flux density at the tips of the teeth.

Curve I—Area = 1,439; ratio, flux density at tip to flux density at middle of tooth surface = 1.21; minimum height for the surface of the tooth = 76.0.

Curve II—Area = 1,810; ratio, flux density at tip to flux density at middle of tooth surface = 1.29; minimum height over the surface of the tooth = 72.5.

Curve III—Area = 1,879; ratio, flux

density at tip to flux density at middle of tooth surface = 1.28; minimum height over the surface of the tooth = 75.0.

Curve IV—Area = 2,232; ratio, flux density at tip to flux density at middle of tooth surface = 1.34; minimum height over the surface of the tooth = 73.3.

These curves also show that the leakage of flux from the flanks of the teeth to the

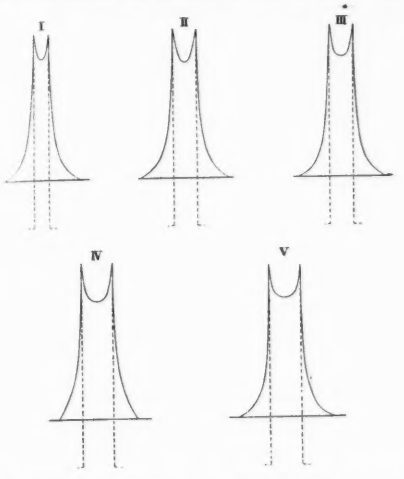


FIG. 11.—FLUX DISTRIBUTION ON THE SURFACES AND FLANKS OF THE TEETH.

Air-gap = 7.3 millimetres. Average flux density at surface of a tooth, about 5,000 lines per square centimetre.

surface of the pole piece is increased with increased gap, as would of course be expected.

Experiment 4—A second experiment was made with a gap of 5.3 millimetres, but with a much higher flux density than previously, *viz.*, 13,500 lines per square centimetre. The curves so obtained are plotted in Fig. 12, and the numerical results are as follows:

Curve I—Area = 1,813; mean height = 73.5; maximum height = 92.7; minimum height = 57.0.

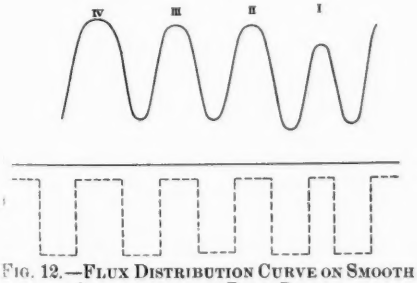


FIG. 12.—FLUX DISTRIBUTION CURVE ON SMOOTH SURFACE OF THE POLE PIECE.

Air-gap = 5.3 millimetres. Average flux density at the surface of a tooth, about 13,500 lines per square centimetre.

Curve II—Area = 2,416; mean height = 80.5; maximum height = 99.7; minimum height = 60.0.

Curve III—Area = 2,445; mean height = 81.5; maximum height = 99.8; minimum height = 60.0.

Curve IV—Area = 2,905; mean height = 84.0; maximum height = 102.0; minimum height = 61.0.

The curves of Fig. 13 show the corresponding flux distribution on the surfaces and flanks of the teeth. The increase of flux density has apparently had the effect of increasing the relative magnitude of the flux peak at the tooth tips.

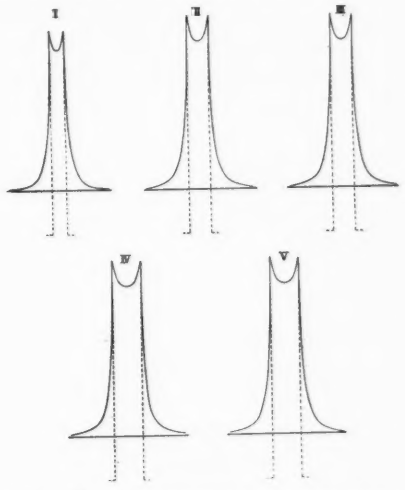


FIG. 13.—FLUX DISTRIBUTION ON THE SURFACES AND FLANKS OF THE TEETH.

Air-gap = 5.3 millimetres. Average flux density at the surface of a tooth, about 13,500 lines per square centimetre.

Curve I—Area = 1,760; ratio, flux density at tip to flux density at middle of tooth surface = 1.14 minimum height for the surface of the tooth = 96.3.

Curve II—Area = 2,408; ratio, flux density at tip to flux density at middle of tooth surface = 1.18; minimum height over the surface of the tooth = 102.0.

Curve III—Area = 2,372; ratio, flux density at tip to flux density at middle of tooth surface = 1.18; minimum height over the surface of the tooth = 102.0.

Curve IV—Area = 2,754; ratio, flux density at tip to flux density at middle of tooth surface = 1.18; minimum height over the surface of the tooth = 103.5.

(To be concluded.)

Poor Outlook for Chilean Copper Mines.

Consul Alfred A. Winslow, of Valparaiso, reports that the government official report shows there have been 7,854 copper claims worked in Chile at different times, of which only 748 were worked during the year just closed. Many of these mines are rich in copper, but with the high price of labor and the poor transportation facilities, few, if any, can be made to pay at the present low price of copper, save those equipped with up-to-date machinery. These are limited, and should the present conditions continue, the production of copper in Chile for 1908, it is estimated, will not be one-half that for last year. The future for the mining interests does not seem bright at present. The scarcity and high price of labor are factors that bear heavily on this industry in this part of the world. There seems to be plenty of rich ore in the country, but the trouble is with the methods in general used to get it ready for the market. More up-to-date machinery and methods are needed to make the business profitable.

Electric Power from Wind.

According to Consul-General Richard Guenther, of Frankfort, German papers state that in Germany wind motors as power generators for use in agricultural and industrial pursuits are rarely met with, but that in Denmark their use has increased very greatly. The consul-general continues:

"Since 1897 the Danish Government has contributed about $28,000 for equipments and has even lately erected an experimental station at Askoc. A technical writer describes these experiments, which were made on the initiative of the Danish Government, and also some of the electric works in Denmark which generate electricity by means of wind motors. According to his statements, motors with four wings have given the best results, as a smaller number of wings does not fully utilize the wind power, while a larger number acts detrimentally upon the wind current between the wings.

"If a medium-large wind motor is used with a wing surface of about forty-eight square metres (one square metre = 10.764 square feet), eight horse-power is obtained at a wind velocity of six metres per second (one metre = 3.28 feet). At a velocity of eight metres the horse-power is more than doubled. A wind with a velocity of eight metres per second is no rarity. The weather reports classify it as No. 3, while the highest wind velocity is No. 12. Since 1903 there has been in existence the Danish Electricity Company, from whose agitation thirty larger and smaller wind-power electrical equipments are in operation throughout Denmark."

The Supreme Court of the United States has rendered a decision in favor of the city of Hutchinson, Kan., in the suit brought by the water, light and gas company to restrain the city from granting a franchise to and making a contract with a competing company. This takes away from the city the privilege, unless expressly granted by the legislature, to grant an exclusive franchise to a public service corporation.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Recent Improvements in the Mercury Electrolytic Meter.

A discussion is given here by H. S. Hatfield of the various difficulties which were met when the Wright mercury electrolytic meter was put into service, and the methods which have since been adopted to overcome these faults. The instrument consists of a glass vessel of peculiar shape, in which there is a mercury anode and a cathode of some other metal. The solution first employed was mercuric nitrate and nitric acid, and but a very small part of the total current passed through the meter. As the electrolytic action which took place in the latter was strictly proportional to the current passing, the instrument should be equally accurate at all loads. The first arrangement, however, did not prove satisfactory because the free nitric acid attacked the mercury, forming mercurous nitrate, and the electrolyte did not remain stable throughout any considerable period of time. The latter increased in resistance with time, and finally crystals were formed within the electrolyte. It became necessary, therefore, to secure a new electrolyte which would be free from the objections mentioned. To do this it was necessary that the salt used should be permanent — that is, that it should not change spontaneously; it should not react with metallic mercury nor with the glass nor the cathode, and it should not be affected by light. After a long search the author finally decided upon a double salt of mercury and iodine with one of the alkaline metals, the particular mixture being secured by adding mercurous iodide to potassium iodide. This solution was found to be free from the objections mentioned. To avoid difficulties at the cathode, an iridium plate is used instead of platinum, which was found to amalgamate somewhat when used with this solution. The iridium is treated with a sand blast to give it greater hardness. It was also found that a pure glass, such as Jena glass, is necessary, as the presence of lead in the ordinary grades of glass is detrimental to the meter. Careful tests of the meter when set up in this way have shown that there is no spontaneous change in the electrolyte and that light has no effect. The meter has also been improved mechanically by avoiding all mechanical connections when possible, joints being made by welding parts together.—*Abstracted from the Electrician (London), December 6 and 13.*

Sound as a Means of Controlling Operations at a Distance.

A method of utilizing sound waves instead of electric waves for controlling mechanisms at a distance is described here by John Gardner. The preferred medium for transmission of sound is water, but when the distance over which control is required is short, air is satisfactory. The system does not require that the sounds be produced in any peculiar manner, but it is essential that they shall have a definite and constant musical pitch, duration and interval. In some cases where it is necessary to avoid accidental interferences, several sounds of different pitch are required to act upon the devices simultaneously before the required control is effected. This device is generally used to close a local circuit. It consists of a vibrator in the form of a strip of steel mounted by one or both ends on a part, such as the plating of a vessel, which is exposed to the arriving sound. The vibrator partakes in this way of all impulses reaching the ship's skin, but as it is tuned to a definite note, only the desired component of these vibrations is amplified by the sympathetic vibrations of the strip to such a degree as to bring about the initial electrical action upon which all further effects at the receiving station depend. Even after amplification the disturbance of the strip is extremely small, and no change of condition can be perceived even with a magnifying glass. This motion is so small that no mechanical adjustment will be fine enough, although telegraphic relays are sometimes adjusted to have a travel of but one-one-thousandth of an inch. No contact adjustment would, therefore, be suitable, but in place of this a microphone is used, the vibrations of the apparatus being caused to increase the resistance of this microphone to such a degree as to allow a relay held open by the current flowing through the microphone to close the controlling circuit. No vibration occurs at the relay itself, so that the latter remains open or closed according to whether the vibrator is being affected by a note of the necessary pitch or not. By placing a number of these vibrators in parallel in the relay circuit, the latter will remain open except when all the vibrators are simultaneously acted upon by the respective notes to which they are tuned. It has been found that the most sensitive arrangement is secured when the microphone is not attached to the central or the "loop" point of the vibrator, as in this position it tends to damp the latter's movement. When placed a little to one side of this, the actual movement of the microphone pencil is greater. It is suggested by the author that this arrangement might find application for various purposes and particularly in connection with submarine signaling. By attaching it to the vessel a visual signal may be given when the ship comes within range of the sound of a submarine bell. By having two of these devices on the sides of the ship a means for determining the direction in which the sound is coming is secured. It is suggested, also, that the apparatus affords a sort of telegraphic system which would be suitable for communicating with submarine vessels. Also, by the employment of a step-by-step subsidiary motion, several distinct operations may be controlled at the receiving station.—*Abstracted from the Electrical Review (London), December 13.*

Rail Corrugation.

In spite of the many theories that have been advanced to account for the existence of corrugations on street railway rails, none of these seemed to Andrew Forbes entirely satisfactory. He has made a special study of this problem and conducted some experiments which seem to bear out his conclusions. He thinks that one of the causes is a more frequent use by the motorman of the brakes than is necessary for actually stopping the car. He has noticed many cases in which the motorman depended upon the brakes for controlling the speed of his car. A contributing cause is the looseness of the rails, which is often more than is believed. This looseness may be caused by the run-

ing of the cars, but it is probably also due in part to uneven heating and cooling of long, rigid lengths of track. Whenever one rail of a track is suddenly plunged into shade by neighboring buildings, strains must be set up which will tend to loosen the rails. There is a vibration set up by the cars which is plainly noticeable in neighboring buildings, more so than on the cars themselves, where it is largely absorbed by the springs. As car bodies are now mounted there is a certain amount of longitudinal motion through the springs, and it is this longitudinal freedom which the author believes is the primary cause of the corrugations. When stopping or starting a car this relative displacement of the body of the car with respect to the truck brings a varying force to play on the wheel. If, for example, the car is stopping and the brake-shoes grip the wheel, the latter will momentarily stop while the body moves forward. When additional force thus brought to play upon the wheel is sufficient to cause it to move, it will do this with a jerk, either skidding on the rail or slipping against the brake; then the wheel is again checked by the brake and this process repeated. The effect is thus to bring to bear a force on the rail not perpendicular to its surface, as when the wheel is rolling, but forward of this, thus tending to roll the rail up into corrugations just as though a series of hammer blows were delivered upon the surface at an angle. If the rail is free to vibrate, it will do this, and this action will cause the wheels to slip and stop in tune with the rail, thus accentuating the effect. The result is that the upper layers of the steel are displaced. The reason why this effect has been known only since the introduction of electric cars is because of the higher speed and greater weight of these cars as compared with the old horse-cars. Mr. Forbes then describes an experiment which seems to bear out his idea. A wooden rail about two feet long is supported at its ends. Over this may be passed a wheel attached to a sleeve slipping upon a guide. If this wheel be free to rotate, and will move with respect to the slide vertically only, no corrugations will be formed on the wooden rail. When, however, the wheel is supported on arms and by a spring so that it may move longitudinally with respect to the sleeve, and the wheel is prevented from turning, this arrangement will form corrugations in the wooden wheel if it be moved back and forth on the rail. The same effect will be brought about by allowing the wheel to turn against a resistance. A rather delicate adjustment is necessary in this case. The author also points out that when this action has taken place the bright spots on the rail are not at the crest of the corrugations but a little below it, but after some time the crest itself becomes bright, due to the additional wear at this point. This he thinks accounts for the fact that occasionally corrugations have appeared and later disappeared, the wheels themselves wearing them down.—*Abstracted from the Tramway and Railway World (London), December 5.*

Windmills for Driving Dynamos in Denmark.

Some details are given here of the work which is being done in Denmark to adapt the windmill to driving dynamos. This has been referred to several times in the ELECTRICAL REVIEW. The work has been going on steadily, and at the present time there are thirty power stations driven in this way, these having been installed by a Danish company. They are said to be in a flourishing condition. The newest type of wheel used for this purpose is placed about fifty-five feet from the ground with sails about thirty-five feet long and eight feet broad. They have four sails, which number has been found to give the most efficient results. Fewer sails do not utilize fully the power of the wind, and when more are used each one interferes with the wind acting upon the others. These sails are designed carefully, it being necessary to pay particular attention to the front or leading edge of the sail so as to avoid setting up eddying currents back of it. The best results are obtained when the peripheral velocity of the sail is two and a half times greater than that of the wind, and when the face of the sail is but little inclined, the angle forming about ten degrees to the direction of motion at the outer tip and about twenty-five degrees near the centre of the wheel. The relation between power and output in kilowatts of such a wheel is given by the following equation: $P = \frac{S V^3}{1670}$, where P represents the power in kilowatts; S the surface of the sails in square metres, and V the velocity of the wind in metres per second. A recent installation of this character was that at the public high school of Vallekilde in New Zealand. The wheel is installed on a tower a short distance from the school. The power station is beside it instead of being placed within the supporting structure. The wheel is placed about forty-two feet from the ground, and is about forty-five feet in diameter, having a total surface of thirty-one and one-half square metres. It develops 6.3 kilowatts in a wind having a mean velocity of seven metres a second. The sails are designed according to the principles indicated above; in addition, they are divided longitudinally into ten parts, which can be turned with the wind when the latter is very violent. To obtain automatic regulation these vanes are held against the wind by means of a weight and open when the pressure on them exceeds a certain limit. This wheel is turned to face the wind automatically by means of two smaller wheels driven by the wind. With a wind of seven metres a second the angular velocity of the wheel is about twenty-four revolutions a minute. The axle drives through double bevel gears a countershaft which in turn, through a second countershaft, drives the generator. To maintain the speed of the latter fairly constant, the tension on the belt between the two countershafts is regulated by a weight acting upon arms which carry the lower shaft. With this arrangement the torque transmitted from the first to the second countershaft is practically constant, independent of the speed of the first shaft, and when the latter runs more rapidly the belt slips on the lower pulley. Thus the load upon the generator is automatically adjusted, and as the latter is used for charging storage batteries, the slight change in speed which takes place as the current output is decreased is an advantage. This particular machine has an output of fifty amperes, the voltage varying from 110 to 160. The power varies from five and one-half to eight kilowatts. To prevent discharge of the batteries through the generator when the voltage of the latter is higher than that of the batteries, an automatic reverse-current circuit-breaker is introduced. The batteries in the station supply 378 incandescent lamps and six arc lamps. During the winter months, when the load is heaviest, the greatest duty is 270 ampere-hours. To provide for contingencies a gasolene engine has been installed in this station, the cost of which is almost as much as that of the windmill. The mill itself cost about $690; the dynamo about $255; batteries, $1,100, and the gasolene engine $605; the total cost of the entire equipment is $3,750. During one year, when the wind was least favorable for the operation of the wheel, it was necessary to run the gasolene engine only ninety hours. For six months it was not at all necessary to start this engine.—*Translated and abstracted from L'Industrie Électrique (Paris), December 10.*

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

A New Recording Milli-Voltmeter and Shunt Ammeter.

Electrical engineers have long felt the need for an accurate and sensitive recording milli-voltmeter which is adapted to practical every-day service as well as for laboratory tests. There has also been a demand for a recording ammeter of the shunt type which can be connected by leads to the main bus-bar. The shunt system is especially economical where heavy currents are to be indicated or recorded, as the instruments may be located at a considerable distance from the main current, thus saving great expense in carrying the main conductors to the point where the instrument is located. The recorders illustrated herewith have been designed to meet these particular demands.

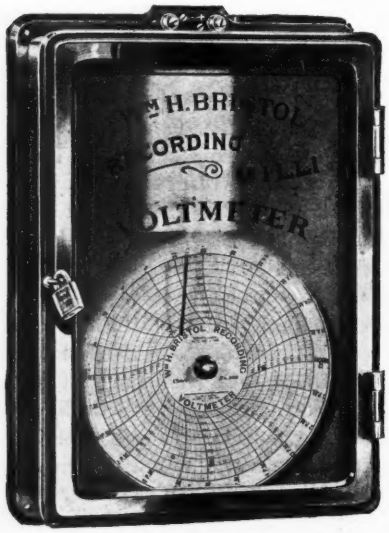


FIG. 1.—RECORDING MILLI-VOLTMETER.

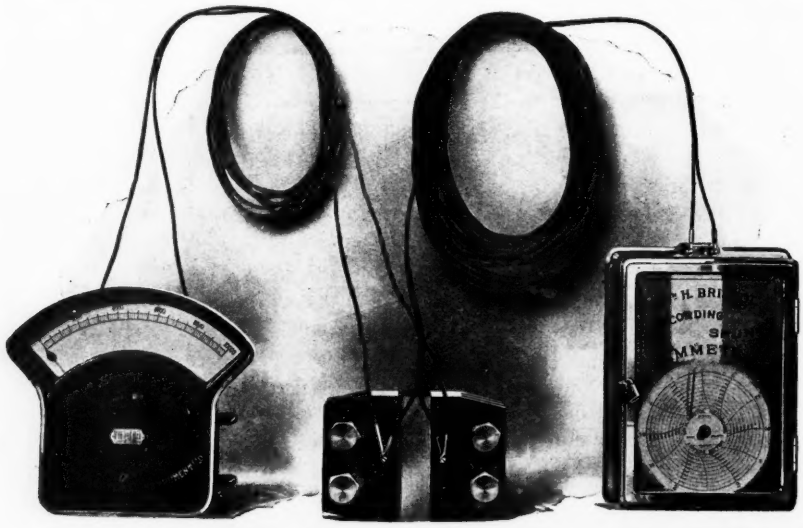


FIG. 3.—WESTON AMMETER AND WM. H. BRISTOL SHUNT RECORDING AMMETER.

The two most important fundamental features of these recorders are a sensitive electrical movement of special design made by the Weston Electrical Instrument Company, and a new recording system using a patented smoked chart so arranged that there is absolutely no friction between the recording arm and the chart.

These instruments are so sensitive that the recording arm will move over the whole scale for five milli-volts or less, making it possible to accurately record one ten-thousandth of one volt. The graduations on the chart are evenly proportioned over the entire range, the same as the Weston ammeter, so that even though there is only a small current flowing, the readings may be as readily taken as if the current was the maximum that the instrument would record. This feature will be greatly appreciated, as there are many places where it is desired to install instruments for increasing future demands, and it is important that the records be perfectly clear, even though the loads are very light when the outfit is first installed.

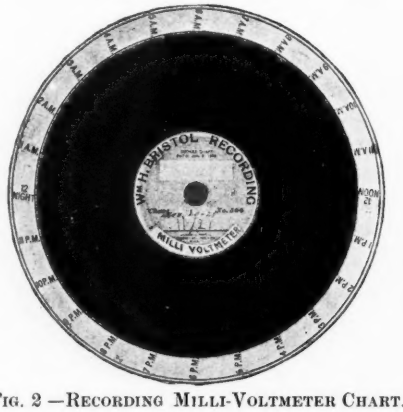


FIG. 2.—RECORDING MILLI-VOLTMETER CHART.

The records are made on a novel semi-transparent smoked chart, which is periodically brought into momentary contact with the end of the recording arm by means of a special vibrating device. In this way a series of white dots are made on the smoked surface and these form a continuous line, and a record is thus made without causing any friction between the moving arm and the chart. The rate of vibration of the chart is timed to suit the frequency and range of the variation in the current to be recorded. The usual period of vibration of the chart is once in ten seconds, but to obtain continuous lines where the fluctuations of the current are quite rapid, the vibrating attachment is made to operate twice every second. When the record is completed the chart is dipped in a simple fixative solution which makes the record permanent for filing.

The recording milli-voltmeter as shown in Fig. 1 and Fig. 2 is a reduced photographic facsimile of a chart taken from one of these instruments in connection with electrolysis surveys of underground structures which are being conducted by the Electrical Testing Laboratories of New York city. The graduations of this chart are arbitrary. It was revolved once in twenty-four hours and was vibrated once every ten seconds. The zero position of the recording arm was the middle of the scale, so that the record might be independent of the direction of the current, as in many cases the direction of the current changes from negative to positive during the day.

It is expected that by using a number of these instruments, operating simultaneously at different points, stray currents in water and gas mains, or in any underground structure, may be recorded, making it possible to discover the causes of trouble and how they may be eliminated.

The recording ammeter is shown in Fig. 3, connected to a standard Weston 10,000-ampere shunt, to which is also connected a Weston indicating station ammeter. This illustration shows that the recorder may be readily applied to any standard shunt which is already in service without disturbing the indicating instrument at the switchboard. As illustrated here, leads of almost any desired length may be used to connect the indicating and recording instruments to the shunt on the main bus-bar. It is even possible to have the recording ammeter located in the superintendent's office at a great distance from the shunt and the indicating instrument located on the switchboard convenient for the observation of the operator. Such combination outfits could be furnished as units, with leads of the proper lengths to suit the individual cases.

Fig. 1.—New Benjamin Attachment Plug.

The recording shunt ammeter has been successfully applied for taking continuous records of the current on a large trolley system, where the fluctuations are very rapid, and varied as much as 4,000 amperes several times in a minute. The charts for such work as this are made to revolve once in one hour and the vibrator operates twice in one second. For preliminary tests the recorders are provided with special fast vibrators for the smoked chart and with a clock movement to revolve the chart once in one hour, but for continuous daily records the standard twenty-four-hour charts are recommended.

These instruments are manufactured by Wm. H. Bristol, 45 Vesey street, New York city.

Some New Benjamin Specialties.

The Benjamin Electric Manufacturing Company, Chicago, Ill., has placed on the market a line of electrical specialties which has met with instant approval throughout the trade. These specialties possess many features of considerable merit, and fill a want which has for a long time caused a great deal of trouble in the utilization of electrical appliances.

Fig. 1 shows a new attachment plug which is equipped with a rotating sleeve, making it possible to attach the plug without twisting the cord or turning the plug proper. The illustration shows a sectional view, which indicates the rotating sleeve and fibre flange. Another feature of this attachment plug is the cord grip, which consists of a porcelain yoke which causes the cords to separate; the separated cords, in turn, being firmly clamped against the cord grip by a threaded bushing forming the removable cap. This is a feature of great importance in this line of work, as it does away entirely with the knotting up of the cord, and relieves the binding-posts of any strain, also making possible a neater and very much more serviceable cap. The body of the plug is of high-grade porcelain, the flange of black vulcanized fibre and the removable cap of a tough black composition.

Fig. 2.—Current Tap.

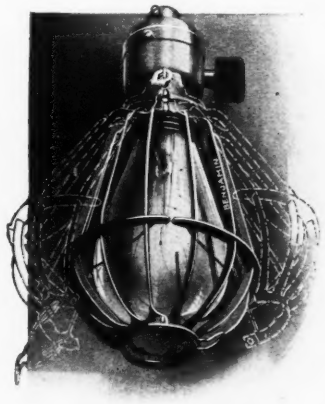


Fig. 4.—New Form of Steel Lamp Guard.

Fig. 2 shows a current tap which embodies some of the features of merit of the attachment plug just described. The current tap is equipped with a rotating sleeve, which makes it unnecessary to turn the device in order to attach it to the socket. The rotating element is so arranged that the cord lead may be set in any direction, the flange tightened and the cord adjusted to follow any angle or line desired. The porcelain base is well protected and shielded from mechanical injury. In the cord connection the binding-posts are relieved of any strain by the insertion of a hard-fibre yoke which spreads the cord connectors, these cords being gripped by an externally threaded bushing which takes up the strain between the nipple and the separating yoke.

Fig. 3 shows a new hand portable lamp guard, which is designed especially for use behind switchboards or in localities where there is danger of a metallic substance short-circuiting contacts through which large volumes of current are flowing. This portable is made entirely of wood and hard fibre. The porcelain socket is deeply embedded in the body of the wooden handle, but may be removed by the withdrawing of two countersunk screws. The guard parts are formed edgewise radially with the lamp, and the distribution of light is as free as with a metallic guard of smaller dimensions. This hand portable is light and very strongly constructed, and should absolutely fulfil the conditions for which it has been designed.

Fig. 3.—New Hand Portable Lamp Guard.

Fig. 4 shows the new form of steel lamp guard which the company has recently designed. This guard consists of two halves pressed up from a single sheet of steel, with reinforced ribs. The parts are hinged together and grip the socket tightly, relieving the lamps of strain. A resilient spring wire supports the lamp centrally in the guard, preventing the bulb from coming in contact with the sides of the guard. The metal is formed edgewise radially with the lamp, permitting free light distribution. The guard is clamped together and held in position by lugs and kept from edgewise movement by a spring lock, which holds the halves rigidly in position.

Another specialty which the company has recently placed on the market is an ornamental stamped brass husk, adapted to be slipped over the shell of either a single lamp or used with a cluster.

Electric Paper Hoists.

In large printing plants the transfer of the paper from the storage rack to the press is a task which yearly has become more and more arduous to the pressmen.

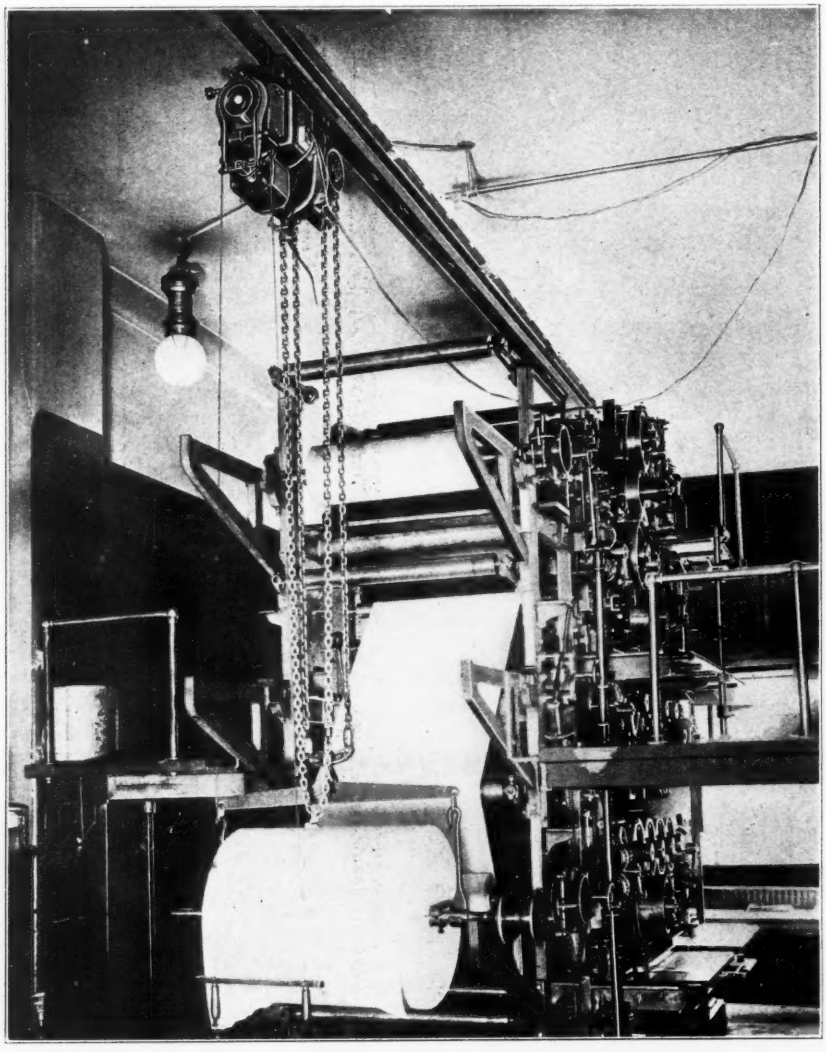
In years gone by the paper was easily transferred by hand, but as the demands became greater, the size and weight of the paper increased and chain blocks were installed to do the work. With the still further increased demands now made upon large printing plants, especially those devoted to newspaper work, the chain blocks are as inadequate as were the manual methods of former years, being slow and not easily operated.

Electric hoists, on the other hand, are quickly and easily operated, and are particularly well adapted for the purpose. They are now used in many pressrooms throughout the country.

The accompanying illustration shows one of the Sprague Electric Company's electric paper hoists recently installed in the printing plant of the Pittsburg *Gazette-Times* at Pittsburg, Pa. This is a two-chain hoist, operated by a three-horse-power, 115-volt, direct-current, enclosed series Sprague motor. Its maximum capacity is 4,000 pounds on the hook at a lifting speed of ten feet per minute, and the maximum height of lift is fifteen feet.

This hoist is operated from the floor by pendant ropes which connect with a single-speed controller mounted on the trolley carriage. It is fitted with a mechanical brake.

The Sprague Electric Company, 527-531 West Thirty-fourth street, New York city, manufactures these electric paper hoists for operation on 115, 230 or 500-volt, direct-current circuits, and in capacities from 1,000 to 6,000 pounds.



SPRAGUE ELECTRIC HOIST INSTALLED IN PRINTING PLANT OF THE "GAZETTE-TIMES," PITTSBURG, PA.

Among the newspaper plants using the Sprague electric hoists are the following: Boston *Post,* Boston *American,* Boston *Herald,* Boston, Mass.; New York *Times,* New York *World,* New York *Herald,* New York *Commercial,* New York city, N. Y.; Pittsburg *Gazette,* Pittsburg *Gazette-Times,* Pittsburg, Pa.; Cleveland *News,* Cleveland *Leader,* Cleveland, Ohio; Philadelphia *Item,* Philadelphia, Pa.; Buffalo *Courier,* Buffalo, N. Y.; Fort Worth *Record,* Fort Worth, Tex.; New Orleans *Picayune,* New Orleans, La.; the Bulletin Company, Philadelphia, Pa.; the *News-Leader,* Richmond, Va.; Muncie *Star,* Muncie, Ind.

The Westinghouse Storage-Battery Autotruck for Industrial Railways.

Beset by the problem common to all large industrial establishments of transporting material from one part of the works to another in an economical manner, the Westinghouse Machine Company found the most satisfactory solution in storage-battery autotrucks of its own design and construction.

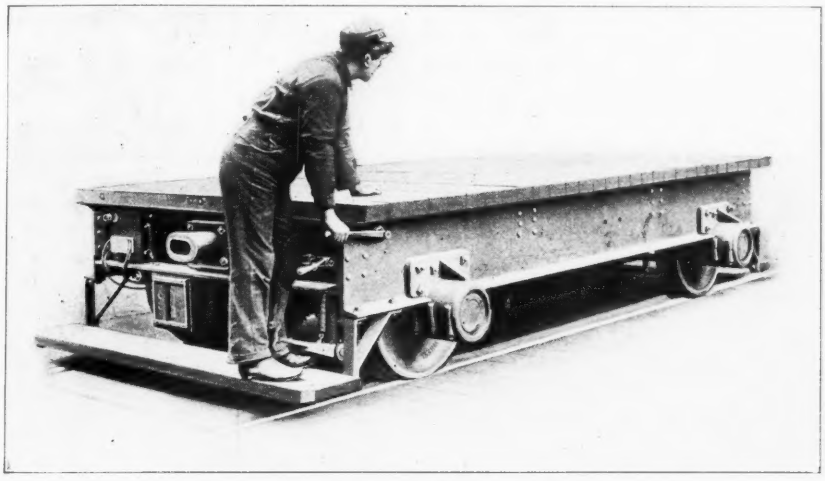
Convinced by the results obtained during several years of continuous service of their fitness for the purpose, the company has put the trucks on the market and is now prepared to furnish them in capacities of from ten to forty tons.

The system in use in the works of the Westinghouse Machine Company previous to their introduction consisted of small cast-iron trucks of three-foot gauge, moved by hand, whose load was necessarily restricted to a few tons. Heavy castings were transported to a position where they could be handled by the overhead cranes by means of fifty-ton trucks, which were usually moved by a rope passing under a snatch block and attached to a crane hook.

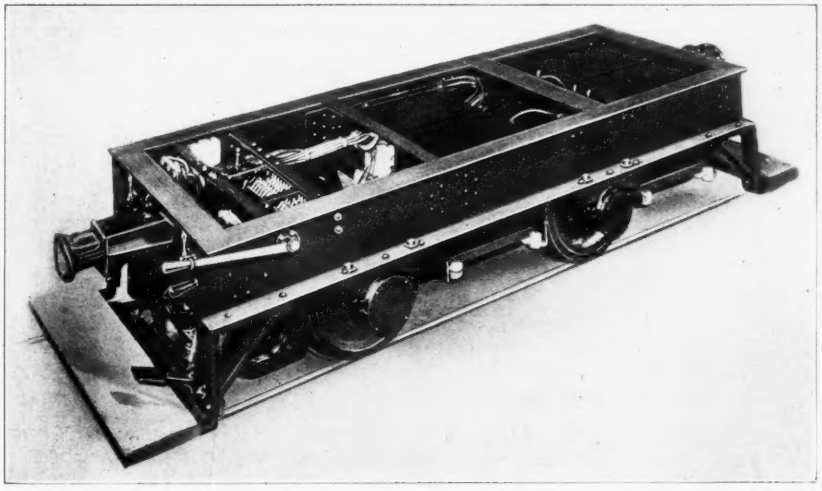
When the storage-battery autotrucks were installed, a surprising change took place. On account of the facility with which the trucks could be handled, delays of material in transit were practically done away with, and since the trucks furnished their own power the number of laborers required for the moving of material was greatly reduced. More important still, there was a marked improvement in crane service, since a crane was no longer needed for transporting castings below ten tons in weight (the first trucks installed being of ten tons' capacity) from one end of the long shops to the other, driving several cranes before it and putting them temporarily out of

commission. When larger trucks were added there was a corresponding further improvement in crane service.

The trucks, though of extremely simple construction, are very substantially made of the best materials. A steel frame, thoroughly braced, is carried on four wheels, the journals of which run in roller bearings. The driving axle or axles, as the case may be, carry the motor, or motors, as in street-railway practice. The motor is spring suspended from the frame at one end, and connected to the driving axle by suitable reduction gearing. A spring-suspended cradle of angle iron carries the battery trays.



Westinghouse Storage-Battery Autotruck.



Body and Running Gear of Westinghouse Storage-Battery Autotruck.

At the operating end of the truck are mounted the controller, brake, charging receptacle, cutout switch and volt-ammeter. A convenient step and draw-bar head are provided at each end.

All the machinery is below the top of the frame and is covered by a heavy wooden deck for carrying the load. This deck is made in sections, so that any part of the mechanism is readily accessible.

The motor is of the well-known Westinghouse vehicle type, capable of standing heavy overloads, is dustproof and self-oiling. The controller is also of the Westinghouse vehicle type, giving four speeds in either direction. It is provided with operating and reverse levers, which are interlocking to prevent premature reversal, thus protecting the motor and the batteries.

The battery is contained in two or more trays of cells, and is of ample capacity for the particular service. It is especially designed to operate at high rates of charge and discharge, and, therefore, a battery of four or five times the capacity, as is usually the practice in similar service, is not needed, since the plates in this battery are capable of discharging at a very high rate for three or four minutes at a time without injury. Another reason for adopting a battery of smaller ampere-hour capacity than is customary in similar work is that the time available for charging during the working hours is usually thrice the period of time that the truck is actually running. Charging is made so simple that the truck can easily be charged during these idle periods.

During a six months' test of the standard ten-ton truck herewith illustrated, the power required to charge the battery in regular and heavy shop service was accurately metered. It averaged sixty-three kilowatt-hours per month. At the figure of five cents per kilowatt-hour, the cost for the current would be only $3.15. The work done was recorded, and averaged practically 700 ton-miles per month, the loads running from a few hundred pounds to fifteen tons.

These trucks, used as locomotives on a level track and without any weight to secure adhesion, can haul, on suitable cars, from one-half to their full rated capacity as a truck, depending upon the condition of the track and kind of bearings on the cars hauled. By placing sufficient weight over the drivers to secure adhesion, they are capable of handling from one to two times their capacity as a truck for a continuous period of not more than five minutes.

Standard trucks are made for six different gauges, namely: 18, 21½, 24, 30 and 36 inches, and 4 feet 8½ inches. For track systems provided with turn-tables, they are made with rigid trucks. Where tracks are installed with curves, the trucks, for all gauges up to thirty-six inches, are provided with swiveled front axle, permitting free operation on curves as low as twelve feet in radius.

The "Luxol" Advertising Sign.

The Edison & Swan United Electric Light Company, Limited, 36-37 Queen street, London, E. C., has placed on the market a new type of electric sign. This sign is made with fully rounded glass letters mounted so as to be interchangeable. The letters are snow white in color and are made with beveled edges. The sign is for daylight as well as for night service. A single five-candle-power lamp is sufficient to illuminate an eight-inch letter. The letters can be obtained in ranges of size suitable for all classes of premises, varying from four to sixteen-inch letters. When the letters are fixed the lamp and holder are completely covered. The sign is sold under the name of "Luxol." It may be arranged to work with a motor-driven switch for flashing, changing colors or switching on letters in rotation.

Current Electrical News

DOMESTIC AND EXPORT.

WORK TO BEGIN ON IOWA INTERURBAN—It is expected that work will soon be commenced on the proposed Clinton-Dubuque (Iowa) interurban road, surveys having been completed. The building of the line means the expenditure of about $2,500,000. The proposition is to construct a third-rail system of railroad between Clinton and Dubuque, and to install the trolley system only when necessary in the cities and towns passed through. T. J. Wilcox is behind the undertaking.

NEW MEXICAN LIGHT AND POWER COMPANY—Messrs. Braniff, of Mexico City, and Segura and Garcin, of Orizaba, have formed a new company to exploit electric light and motive power from one of the strongest water-power plants in the state of Vera Cruz. The company is organized with a capital of several million dollars under the title of "Cia de Fuerza Motria y Luz Electrica de Orizaba." It is proposed to supply the cities of Orizaba, Cordoba and neighboring towns with ample light and power for local consumption.

STREET RAILWAY COMPANY SUED—Suit to recover $730,000 from the Illinois Central Traction Company for alleged violation of the village ordinance has been filed in the Circuit Court by the East Springfield (Ill.) board. It is alleged the company has violated a measure providing the company shall pay $10 upon each interurban car run within the corporation. The ordinance was passed at a session of the East Springfield board September 4, 1906, and a penalty for a violation of not less than $25 or more than $200 is provided. The declaration says the company has run ten cars each day on Twentieth street for the year ended October 1, 1907. It is also charged no license has been paid, as provided in the village ordinance.

COLORADO POWER COMPANIES TO RESUME WORK—The Central Colorado Power Company, capitalized at $22,500,000, and the Eastern Colorado Power Company, a subsidiary organization, capitalized at $7,000,000, which practically ceased work on extensive canals and reservoirs connected with large electric power schemes when the Knickerbocker Trust Company failed, will resume operations with increased forces. Under recent embarrassing conditions in financial circles and the fact that winter was close at hand, the companies reduced their working forces by about two thousand men, although at no time was the underground work suspended. Interested in both companies are: Thomas F. Walsh, D. H. Moffat and others of Denver; former Governor Myron Herrick, of Ohio, and Eastern European and Colorado Springs capitalists. The companies will eventually supply all of eastern and central Colorado with electric power.

NEW ELECTRIC LINE TO RUN THROUGH THE INDIANA AND ILLINOIS COAL FIELDS—The Indianapolis-Cairo Traction Company, which has as its purpose the construction and operation of an electric traction line from Indianapolis to Cairo, Ill., through the Indiana and Illinois coal fields, has been incorporated under the laws of Arizona, with a capital of $10,000,000. The incorporators, except for the president, A. L. Hassler, of York, Pa., are Indianapolis men. Besides Mr. Hassler, they are: W. C. Buell, John T. Figg and Charles McDermott, the last one of whom is secretary and treasurer of the company. The company has taken over the Eel River Railroad Company, which was incorporated about two years ago to build a steam road from Indianapolis into the Indiana coal field, and its officers say that a contract is about closed with New York interests to underwrite the company, disposing of the bonds to Paris (France) capitalists. The survey, it is said, has been completed from Indianapolis to Sullivan, Ind.

WEST END STREET RAILWAY—The Massachusetts Railroad Commission has approved of an issue of 20,218 shares of additional common stock by the West End Street Railway Company, and has fixed the issue price at $70 per share. This is the amount of stock asked for as reasonably necessary for payment to the Boston Elevated for additions, improvements and alterations made from April 1, 1904, to September 30, 1907, to the amount of $2,135,750. At a special meeting of the stockholders, called to vote upon the issue of 20,218 shares of additional common stock, 147,394 votes were cast, all but twenty-two of which were in favor of the proposition. The vote was as follows: "That for the purpose of providing means to repay to the Boston Elevated Railway Company amounts expended by it for permanent additions, alterations and improvements on the property of this company the common stock of this company is hereby increased from $10,109,250 to $11,120,150 and the number of common shares is increased from 202,185 of the par value of $50 each to 222,403 of the par value of $50 each, so that the entire common capital stock is and shall be $11,120,150, represented by 222,403 shares of the par value of $50 each."

ELECTRICAL PROGRESS IN CHIHUAHUA—The Compañia Electrica y Ferrocarriles de Chihuahua takes over all the properties of the local street-car company, the Chihuahua Mineral Railroad, Chihuahua, Mexico, and the electrical department of the Compañia Industrial Mexicana this month. This will include all the lights and electrical power in the city, the present street-car system now being converted into a trolley line, the narrow-gauge steam railroad to Santa Eulalia, which now runs four regular mixed trains a day, and the aerial tramways connecting the railroad and town of Santa Eulalia with various mines. The new corporation will open offices in Chihuahua. The properties are at present owned mostly by the same people. For the present work will be confined to the city lines, but later the entire line of the Mineral Railroad will be converted into a trolley system. The city lines are expected to carry freight and will probably build sidings to business houses and haul cars from the Central, Chihuahua and Pacific and Orient railroads direct to consignees. A. C. Nash, the present general manager of the Chihuahua Mineral Railroad and the present city street-car lines, will be general manager of the new corporation.

NEW INCORPORATIONS.

AUSTIN, TEX.—Gorman Light and Power Company, of Gorman, Eastland county. $15,000. Incorporators: F. B. Winters, S. B. Bowles and W. A. Waldrop.

COLUMBUS, OHIO—The Massillon, Wooster & Western Railway Company, Wooster. $10,000. Incorporators: C. V. Hard, M. L. Smyser, A. D. Metz, Albert Shupe, Nick Amster and others.

DENVER, COLO.—The Pueblo & Arkansas Valley Electric Railway Company. $300,000. To extend from Pueblo to Roselawn, Avondale, Vinland and on to Fowler. Incorporators: F. B. Chapman, M. J. Verner, Lester Wolf and N. Douthitt, of Kansas City, and M. G. Saunders, Pueblo.

MADISON, WIS.—Blomkun Electric Company, Milwaukee. $35,000. Incorporators: Frank Blomkun, J. P. Blomkun and Edward J. Yockey. Arkansas Telephone Company, Arkansas, Pepin county. An amendment increasing the capital stock from $2,400 to $5,000. Morris Telephone Company, Morris, Shawano county. $1,200. Incorporators: Charles A. Holm, Thomas Larson and Peter Fredrickson.

SPRINGFIELD, ILL.—Chicago, Joliet & Central Illinois Railway Company, Chicago. $2,500. To construct a line from Chicago, southwesterly through Lyons, in Cook county, Downers Grove, Du Page county; Du Page, in Will county; thence south through Lockport and Joliet, in Will county, and to other points in the counties of Cook, Du Page, Will, Bureau, Peoria, Kendall, Grundy, La Salle, Livingston, Putnam, Marshall, McLean and Woodford. Incorporators and first board of directors: Josiah Burnham, Hugo De Loeb, George L. Turnbull, Gerald Turnbull and L. H. Strickler.

ELECTRIC RAILWAYS.

CHICAGO, ILL.—The City Railway Company has expended $3,600,000 on thirty-one miles of new track, 201 "pay-as-you-enter" cars, on rehabilitation, without counting power improvements, this year.

PINE BLUFF, ARK.—The Little Rock-Pine Bluff Interurban Company, which is building the interurban line between this city and the capital, has established local headquarters and has begun grading.

MARION, IND.—Officials of the Marion & Logansport traction line have announced that bids for the construction of the line will be opened March 1. The survey of the right of way is expected to be completed early in January.

LEXINGTON, KY.—Capt. W. E. English is maturing plans for beginning work on an east and west interurban line that will have Madison for its eastern terminal and will connect with the Indianapolis & Louisville Traction Company at Scottsburg.

PADUCAH, KY.—A corps of engineers has begun surveying a route out of Paducah to Mayfield, a distance of twenty-five miles, for the Paducah Southern Electric Railway. The work of building the road will be pushed rapidly. The line will reach many inland towns.

DENISON, TEX.—It is almost an assured fact that an electric line will be constructed from this city to Sulphur, Okla. The preliminaries have about been completed. Agents of the enterprise are securing right of way through lands between Denison and Red River.

FREDERICK, MD.—A corps of engineers under the direction of Theodore J. King, superintendent of the Great Falls & Old Dominion Railroad Company, has completed a survey from Frederick to Buckeystown for the proposed extension of the Washington, Frederick & Gettysburg road from this city to Washington.

DANVILLE, ILL.—The Illinois Traction System has petitioned the council for a franchise for a new interurban line leaving the city on the southeast, to be known as the Danville & Southeastern Railroad Company, which is designed to connect with the line now running from Terre Haute to Clinton, Ind., owned by the McGowan syndicate.

FORT COLLINS, COLO.—The Denver & Interurban Electric road has begun running cars on the Mountain and Cottage avenue line. About five miles of the system has been completed and is ready for operation. The city council has granted the company an extension of eight months from the first of the year for the completion of its sugar factory branch.

WALLA WALLA, WASH.—By a unanimous vote of the city council a blanket franchise was granted the Washington & Oregon Traction Company, which gives it the privilege of constructing its line along any street in the city excepting Park, Palouse and Alder streets. The franchise is practically a duplicate of the franchise granted several years ago.

NAZARETH, PA.—The Allen Street Railway Company has placed in operation its new line from Nazareth to Bath, a distance of four miles. Another four-mile trolley line, just completed, extends from South Bethlehem to Seidersville, and in the spring will be extended to Centre Valley, connecting with the Philadelphia line of the Lehigh Valley Transit Company.

WORCESTER, MASS.—The Worcester Consolidated Street Railway Company petitions the Railroad Commission that its orders issued October 25, 1901, and August 5, 1902, approving of issues of $445,000 and $350,000 additional capital stock at $116 per share (which stock was not issued) be rescinded and a new order be substituted for an issue of a like amount, at such reduced market price as the board may authorize.

FOND DU LAC, WIS.—According to the annual statement of the Eastern Wisconsin Railway and Light Company the total earnings of the company for the year ended December 1 were $164,366.77. Of this amount the receipts from the railway system were $95,387.80 and from the electric light and power system $68,972.97. The total license fee to be paid by the company is $3,287.22, of which $1,907.76 is for the railway and $1,379.46 for the lighting and power system.

TOLEDO, OHIO—The Lake Shore Electric has closed a deal whereby that company will supply power to the Toledo, Fostoria & Findlay road. A high-tension wire will be strung from the Lake Shore Electric's line at Woodville to a substation on the Toledo, Fostoria & Findlay. The Lake Shore Electric is supplying the power to the line running from Norwalk to Shelby, and also to the Cleveland & Southwestern, for its Lorain-Amherst line.

GREENSBURG, PA.—The proposed street railway between Latrobe and Ligonier is now a certainty. The company has secured the right of way from Latrobe to the outskirts of Ligonier borough, and has also purchased several acres of land, for the purpose of erecting a car barn. The company is known as the Latrobe-Ligonier Street Railway Company, and its stockholders are business men of Pittsburg. All the preliminary work has been completed.

NEW CASTLE, PA.—The Meadville & Conneaut Lake Traction Company is said to be willing to extend its lines from Linesville to Greenville, twenty-two miles, if the Mahoning & Shenango Valley Railway and Light Company will extend its lines from Sharpsville to Greenville. This would give almost a direct line connecting this city with a direct line connecting Youngstown with Greenville, Conneaut Lake, Meadville and Conneaut. It would also give trolley connections with Erie, Pa.

HANNIBAL, MO.—Parties who are said to be interested in the projected Mexico, Santa Fé & Perry interurban are arranging to extend the line to Hannibal from Perry. It is proposed to begin negotiations with the Hannibal & New London Gravel Road Company and the county court of Ralls county with reference to securing the right of way over the gravel road from New London to Hannibal. The projectors contemplate an extension of the St. Louis & St. Charles line to Mexico and the Mexico, Santa Fé & Perry road to Hannibal, thus forming a continuous line from St. Louis to Hannibal.

ALBIA, IOWA.—Cars are now running through the streets of Albia on the Albia Interurban Railway. The line connects Albia with the coal-mining town of Hocking, three miles south of the city, besides running between both depots and through the principal streets of the city. The outlay has been $125,000. It is now the intention to continue the line to Hiteman, six miles north, and on to Buxton, twelve miles in the same direction. This work will be taken up with the opening of spring. The Albia Interurban officers are as follows: President, John P. Reese; vice-president, C. A. Ross; secretary and treasurer, Calvin Manning; chief engineer, C. B. Judd.

STOWE, VT.—The Mt. Mansfield Electric Railway, which runs from this village to Waterbury, a distance of ten and one-half miles, has been sold at auction for the mortgagee, the American Trust Company, of Boston. A. H. Soden, of Boston, president of the street railway company, was the successful bidder at $20,000. It is understood that Mr. Soden plans to extend a line from Stowe to Morrisville, a distance of eight miles. The railway was opened in 1897. The cost of construction is said to have been $250,000. Last March C. E. Burke, of this town, was appointed receiver, and George H. Dale, of Waterbury, managed the road in behalf of the trust company. At the time the road was built the town of Stowe assisted the project by bonding itself to the extent of $40,000.

SPRINGFIELD, OHIO.—A corps of engineers of the Ohio Electric Railway Company, owner of the old Columbus & Lake Michigan, now being electrified between Lima and Defiance is making a final survey of the road. Both the Defiance and Lima city councils have made this road a certainty as an electric interurban by June 1, 1908, by insisting on clauses to this effect in the franchises. At Lima if cars are not in operation into the city by June 1, the company forfeits a twenty-five-year franchise and a large sum of money. In Defiance if cars are not running into the city by the first of June the franchise is forfeited, also $5,000, a certified check for that amount being on deposit in one of the local banks. With the assurance of this line and the completion of the connecting link between Bellefontaine and Lima, cars leaving this city will be able to go over a route which will connect all of the larger cities of the state within a radius of 100 miles.

PERSONAL MENTION.

MR. WILLIAM FERRIS has been made manager of the Kewanee (Ill.) office of the Postal Telegraph Company.

MR. H. L. COOPER has retired from the firm of Viele, Cooper & Blackwell to engage in business for himself. The company will hereafter be known as Viele, Blackwell & Buck.

MR. W. B. ROBERTS, manager of the Atlanta (Ga.) exchange of the Bell Telephone Company, has been promoted to be special agent of the same company, effective January 1.

MR. WILLARD B. STOUGHTON has been engaged as superintendent of the electric light plant of the Danbury & Bethel Gas and Electric Light Company, Danbury, Ct. He succeeds Mr. Charles R. Hodgson, who will go to Mexico City.

MR. GEORGE FABER, of Maringo, Ill., formerly superintendent of the Elgin & Aurora Electric Railway Company, has been made superintendent of the Western Ohio Railway Company, succeeding James K. Gray. Mr. Faber will have headquarters at Wapakoneta, Ohio.

MR. J. E. NORTH, who has been in charge of the electrical engineering department of the central division of the Ohio Electric Railway Company, has tendered his resignation. H. W. Pagan, electrical engineer of the eastern division of the system, will succeed Mr. North.

MESSRS. D. C. AND WILLIAM B. JACKSON announce that they have removed their western office from Madison, Wis., to the Commercial National Bank Building, Chicago, Ill. Mr. William J. Crumpton will be in immediate charge of the Chicago office. Messrs. Jackson also have an office in Boston, Mass.

MR. LOUIS H. CUSHING, who has been superintendent of the Taunton & Pawtucket Street Railway Company, at Attleboro, Mass., for some time past, has severed his connection with the road to become associated with the Dexter Machine Company, of Attleboro. Previous to going to Attleboro Mr. Cushing was identified for seven years with the Shaw street railway syndicate.

MR. ARTHUR W. KING, who for the past three years has been connected with the New England Telephone and Telegraph Company and of late with the contract department of that concern at Augusta, Me., has accepted a position with the Nova Scotia Telephone Company, Halifax, Nova Scotia. Mr. King will have charge of the organization of a contract department for the Canadian company which will have to deal with the establishing of farmers' lines.

MR. E. F. KIRKPATRICK has resigned his connection with the McRoy Clay Works, and on January 1 associated himself with B. S. Barnard & Company, of New York, as vice-president. Mr. Kirkpatrick will make his headquarters at the Monadnock Block, Chicago. Mr. Kirkpatrick is very well known in the engineering field in connection with conduit construction work, and with his new connections he will handle the Barnard underground conduits in the West.

MR. O. BAERWINKEL, who for the past twenty months has been secretary and manager of the Excello Arc Lamp Company, has resigned and sails Saturday, January 4, for Europe on the Kaiserin Augusta Victoria. While Mr. Baerwinkel has not definitely decided upon his future business associations, it is hoped that he will remain allied with Excello interests with headquarters in Germany. His co-workers of the Excello Arc Lamp Company presented him with a very handsome diamond locket as a souvenir of the pleasant association in the past.

MR. ARTHUR V. WAINWRIGHT, state superintendent of lighting for the Connecticut Company, with headquarters at South Norwalk, Ct., has resigned to become manager of the Mohawk Gas Company, of Schenectady, N. Y. Since his appointment as state superintendent of lighting for the Connecticut Company Mr. Wainwright has had charge of the lighting and electric interests in Greenwich, the gas and electric lighting in Norwalk, the electric lighting in New Britain, electric lighting in Waterbury, gas and electric lighting in Naugatuck, electric lighting and water in Branford, electric lighting and water in Suffield and has acted as general superintendent of the New Milford Power Company.

NEW PUBLICATIONS.

THE ROCKY MOUNTAIN BELL TELEPHONE COMPANY—A very interesting booklet has been published by the Rocky Mountain Bell Telephone Company, entitled "The Story of the Rocky Mountain Bell Telephone Company, 1883-1907." This booklet is designed to tell briefly what has been accomplished by this progressive western company among progressive western people; to tell of difficulties met and overcome; of new things created; of a goal set high and the efforts made to reach it. From an historical point of view the book is very valuable and the illustrations bring to one's mind something entirely new and point out conditions which even some old telephone men are not familiar with.

"COAL-MINE ACCIDENTS—THEIR CAUSES AND PREVENTION"—The Department of the Interior, United States Geological Survey, has published a preliminary statistical report, compiled by Clarence Hall and Walter O. Snelling, with an introduction by Joseph A. Holmes, on "Coal-Mine Accidents—Their Causes and Prevention." This publication reviews the fatal accidents in the United States and gives statistics with respect to accidents in this country and abroad. Mine accidents are classified and there is a brief conclusion referring to this part of the bulletin concerning the significance of these statistics. Under the heading of "Prevention of Mine Accidents" the matter of safety lamps is discussed and suggestions are made for eliminating the danger of naked lights coming in contact with combustible gases. The use of safety explosives and the storage of explosives are discussed.

THE NEW WATERSIDE POWER-HOUSE OF THE NEW YORK EDISON COMPANY—The New York Edison Company has published in book form the specifications of its new Waterside power-house. This station is known as Waterside No. 2 power-house and is being erected on a property bounded on the north by Fortieth street, on the south by Thirty-ninth street, on the west by First avenue and on the east by the East river, borough of Manhattan, city of New York. It was thought advisable in the design of the station to provide for either vertical reciprocating engines or for either or both of two types of steam turbine units of the maximum sizes then developed, thus necessitating a compromise between the demands of the various designs. The operating room was laid out to contain twelve 6,000-kilowatt vertical engines or sixteen 5,000-kilowatt vertical turbine units or twelve 5,500-kilowatt horizontal turbine units. The specifications include the drawings for two turbine units of 8,000 kilowatts' capacity each, the turbines to be of the Curtis type and designed to operate condensing, forming part of a contract between the General Electric Company and the New York Edison Company, and drawings for 7,500-kilowatt turbo-generators, forming part of a contract between the Westinghouse Machine Company and the New York Edison Company.

DATES AHEAD.

American Association for the Advancement of Science. Annual meeting, Chicago, Ill., December 30 to January 4.

South Dakota Independent Telephone Association, Mitchell, S. D., January 8-9, 1908.

Chicago Electrical Show. Coliseum, Chicago, January 13-25, 1908.

International Independent Telephone Association. Annual meeting, Chicago, Ill., January 21, 22 and 23, 1908.

Nebraska Independent Telephone Association. Next meeting, Omaha, Neb., January, 1908.

Wisconsin Electrical Contractors' Association. Next meeting, Milwaukee, Wis., January 15, 1908.

Northwestern Electrical Association. Annual meeting, Milwaukee, Wis., January 15-16, 1908.

Ohio Independent Telephone Association. Next meeting, Columbus, Ohio, March 19, 1908.

NEW MANUFACTURING COMPANIES.

ALBANY, N. Y.—The Murphy Electricity Rectifier Company, of Rochester, has been incorporated, its capital to be $1,000,000. Its directors include W. B. Duffy, George W. Aldridge, T. J. Murphy, and others of Rochester.

RENO, NEV.—Articles of incorporation have been filed by the Reno Electrical Works, with the principal place of business in this city. The capital stock of the company is placed at $10,000, and the stock has a par value of $100 per share. The capital stock has been fully subscribed, the following Reno men being stockholders: Frank V. McAvoy, T. W. Martinez and E. M. Curnow.

ELECTRICAL SECURITIES.

Last week was one of considerable dulness in the stock market, there being little incentive to heavy trading, owing to the paucity of time money. There is every indication, however, of a swift ingathering of financial resources and of a return to Eastern banks of moneys so lavishly sent to Western states for crop-moving and seasonable purposes. Banks throughout the country are resuming normal currency distribution, and the year ends with a great shadow lifted from the financial and industrial horizon. The supply of manufactured products in stock is very small and an entirely different condition, thiswise, prevails than that which confronted the country in 1893, 1897 and 1902, when there had to be digested an immense amount of shelf material by a more or less poverty-stricken people. There are, in fact, positive indications of business contraction, and how long this will last is a matter of conjecture. But it is also apparent that a convalescent period has already begun, and the hopefulness which is extant will stimulate the country's institutions to a rapid recovery, while the fire through which they have passed will leave them cleaner and more wholesome for the future.

Dividends have been declared upon the following electrical securities: Utica & Mohawk Valley Railway Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable January 1. Cincinnati Gas and Electric Company; regular quarterly dividend of 1⅛ per cent, payable January 1. Rochester Railway Company; regular dividend of 1¼ per cent on the preferred stock, payable January 2. Syracuse Rapid Transit Company; regular quarterly dividend of 1½ per cent on the preferred stock, payable January 2. Aurora, Elgin & Chicago Railway Co.; regular quarterly dividends of ¾ per cent on the common stock and 1¼ per cent on the preferred stock, payable January 10. Bangor Railway and Electric Company; regular quarterly dividend of 1¼ per cent, payable January 1. Capital Traction Company, Washington, D. C.; regular quarterly dividend of 1½ per cent, payable January 1. City Railway Company, of Dayton, Ohio; regular quarterly dividend of 1¾ per cent on the common stock and 1½ per cent on the preferred stock, both payable January 1. Columbus, Newark & Zainesville Electric Railway Company; regular quarterly dividend of 1½ per cent on the preferred stock, payable December 31. Holyoke Street Railway Company; regular semi-annual dividend of 4 per cent, payable January 1. Forest City Railway Company, of Cleveland; regular quarterly dividend of 1½ per cent, payable January 1.

ELECTRICAL SECURITIES FOR THE WEEK ENDED DECEMBER 28.

New York:	*Closing.*
Allis-Chalmers common	5⅞
Allis-Chalmers preferred	17
Brooklyn Rapid Transit	38¾
Consolidated Gas	96¾
General Electric	112
Interborough-Metropolitan common	7⅛
Interborough-Metropolitan preferred	17½
Kings County Electric	85
Mackay Companies (Postal Telegraph and Cables) common	52¼
Mackay Companies (Postal Telegraph and Cables) preferred	59
Manhattan Elevated	116
Metropolitan Street Railway	23
New York & New Jersey Telephone	93
Western Union	55
Westinghouse Manufacturing Company	42

Directors of the New York & New Jersey Telephone Company have declared the regular quarterly dividend of 1¾ per cent, payable January 15 to stock of record January 4. George B. Moffat, of Moffat & White, was elected a director to succeed Joseph T. Davis, resigned.

The $1,217,000 stock of the Western Union Telegraph Company which is to be listed on the exchange will be distributed to the stockholders as a quarterly dividend in conformity with the resolutions adopted by the directors on December 11. This issuance will make the total amount outstanding $98,587,000. This new stock will carry dividends accruing after January 15. The authorized capital stock of the company is $125,000,000, of which $10,000,000 is reserved to take care of the outstanding $10,000,000 convertible 4 per cent bonds due 1936 and $15,000,000 will be reserved to take care of $15,000,000 of said bonds not yet issued. The stock applied to be listed is a part of the $13,800,000 increase authorized in 1892.

Boston:	*Closing.*
American Telephone and Telegraph	101
Edison Electric Illuminating	205
Massachusetts Electric	38½
New England Telephone	103
Western Telephone and Telegraph preferred	50

The New England Telephone and Telegraph Company closed its current fiscal year with the best record of gross and net earnings in its history. Gross earnings run in excess of $10,500,000, while the gain in net is considerably in excess of the customary annual increase of $200,000. The company, during the past twelve months, has been able to cut down its operating ratio by practical business economies without in any way curtailing maintenance or impairing efficiency of service. The construction work installed during 1907 has been confined largely to actual necessities, so that construction account will show a substantial cash credit at the end of the year.

Philadelphia:	*Closing.*
Electric Company of America	9¼
Electric Storage Battery common	30
Electric Storage Battery preferred	30
Philadelphia Electric	6¼
Philadelphia Rapid Transit	17¼
United Gas Improvement	73½

Electric Storage Battery directors declared a dividend of 1¼ per cent from the net earnings of the company on both common and preferred stocks, which was payable January 2.

Chicago:	*Closing.*
Chicago Telephone	109
Commonwealth Edison	137½
Metropolitan Elevated preferred	46
National Carbon common	55
National Carbon preferred	100½

Directors of the Metropolitan Elevated have postponed action on the regular quarterly dividend of ¾ of 1 per cent on the preferred stock, owing to conditions and the inability of the company to sell its bonds to provide for current improvements. For the calendar year of 1907 the Metropolitan Elevated earned 4½ per cent on the preferred stock after charges.

TELEPHONE AND TELEGRAPH.

OSWEGO, N. Y.—The Bell Telephone Company has completed and placed in operation its new exchange at Oswego.

SILVIS, ILL.—The Silvis board of trustees has granted the Central Union Telephone Company a twenty-year franchise.

ELIZABETH, N. J.—The Hudson & Middlesex Telephone and Telegraph Company will be given a hearing before the city council January 15, on its application for a franchise.

OMAHA, NEB.—The city of Florence has granted the Independent Telephone Company a franchise. One consideration is that the company agrees to build a brick exchange building before January, 1909.

PHILADELPHIA, PA.—A system of wireless telegraphy is to be established between New York and Philadelphia. A permit has been taken out at the office of the Buildings Department for the erection of a wireless telegraph tower, to be located on Chestnut Hill, by an Illinois company. A similar tower is to be erected in New York city.

PAVILION, N. Y.—A representative of the Inter-ocean Telephone Company is organizing a company to be known as the Pavilion Telephone Company, to be an auxiliary. The desire is to form a stock company capitalized at $10,000, with shares at $25, the number of shares issued to any one to be limited to ten. The Inter-ocean proposes to donate all the poles and wire which are now on the ground, to establish an exchange here to be connected with the Le Roy exchange for long-distance business. The annual rental for local unlimited service is to be at the rate of $8 per year.

WINSTON-SALEM, N. C.—The Southern Bell Telephone and Telegraph Company has awarded the contract for the erection in this city of a telephone exchange building on the lot recently purchased on Liberty street. The plans for the structure were drawn by Harry N. Tyler, of Atlanta, Ga. The contract was let to Harwood & Moss, who agree to complete the building in 100 working days. The building will be thirty by fifty-two feet and will be similar in style to the company's buildings in other cities. The company will install the latest and most improved telephone apparatus.

ELECTRIC LIGHTING.

ALAMEDA, CAL.—Improvements costing $30,000 are being made to the municipal electric light and power plant.

BRISTOL, TENN.—The Bristol Gas and Electric Company, it is announced, will spend $100,000 for improvements during 1908.

FORT MORGAN, COLO.—The city council has decided to extend the electric lighting system to take in the extreme western part of the city. The line is being built.

STATESVILLE, N. C.—The Southern Power Company has begun furnishing electricity to Statesville from its plant at Great Falls, S. C., a distance of 104 miles.

SLIDELL, LA.—At a meeting of the board of directors of the Slidell Light and Electric Company an engineer and manager was selected, and the erection of the plant will begin early in January.

BOSTON, MASS.—The Malden Electric Company has petitioned the gas commissioners for approval of an issue of $150,000 additional capital stock, to retire floating debt incurred in enlargements to its plant.

DEXTER, MICH.—It is understood that Thomas Birkett, president of the Dexter Savings Bank, and W. L. McManus, of Petoskey, have asked the council of Petoskey to set a price on the municipal lighting plant.

HOLYOKE, MASS.—Manager W. H. Snow, of the gas and electric light department, asks for an appropriation of $160,000, to be met by a loan, for what he considers necessary improvements at the electric light station.

STREATOR, ILL.—The Illinois Light and Traction Company has been awarded a contract for lighting the streets of the city for the next five years, at a price of $65 per lamp, a reduction of $5 from the last contract price.

SILVIS, ILL.—W. H. Downing has been given a franchise permitting him to operate an electric lighting and gas plant for twenty-five years. The terms permit Silvis at the end of twenty-five years to purchase the property.

JOLIET, ILL.—The village of Rockdale has entered into a forty-year franchise with the Economy Light and Power Company for electric lighting. The price charged for each arc light is $80 a year, and there will be fifteen lamps installed.

OWOSSO, MICH.—The Shiawassee Light and Power Company, operating in the county outside of Owosso, has asked for a twenty-year franchise in Owosso and the lighting contract of the city for ten years. The Shiawassee company underbids the present company.

SIEGFRIED, PA.—At a special meeting of town council the vote was six to one against the establishment by the borough of its own water and lighting plants. The proposition involved the expenditure of about $450,000. The council directed that new contracts be entered into with private companies.

SPRINGDALE, ARK.—An electric light plant will soon be installed at Springdale. The Springdale Electric Light and Power Company has been granted a franchise for twenty-five years. The rate for business houses will be sixty cents per month for sixteen-candle-power lights, and thirty cents for residences.

HARTFORD, CT.—The Hartford City Gas Light Company, it is stated, has appointed President E. B. Bennett, Vice-President George Bullock and Treasurer and General Manager R. E. Slade a committee to consider the advisability of erecting an electric light plant in connection with the gas works on Arch street.

SCRANTON, PA.—A charter has been granted the Jessup Electric Light Company, the purpose of which is to furnish the borough of Jessup with electric light. The incorporators of the company are: W. S. Robertson, of this city; C. P. Ford, of Marshwood; John J. Sweeney, H. V. Lawlor and John Smoulter, of Jessup.

ST. PAUL, MINN.—A notice has been filed by the West Side Power, Heat and Light Company of an increase of its capital stock from $50,000 to $300,000. The company operates an electrical plant which supplies power and light to a number of concerns. The plant is now in operation and the new stock issue is to cover the cost of the installation.

ST. CATHARINES, ONTARIO—St. Catharines has decided to accept the tender of the Niagara Falls Power Company to light its streets until the year 1925 for $39.50 per arc light per year. Heretofore the Hamilton Cataract Power Company has furnished the lighting for $72.50 per light, but offered to make a future contract at the rate of $45. St. Catharines is twelve miles from Niagara Falls.

ROCK ISLAND, ILL.—Davenport parties interested in the water-power project for which a company was incorporated several years ago, with the object of building a canal from Le Claire down the Iowa side, are again agitating the subject. The latest proposition is a dam just above Rock Island. This, it is held, would have a fall of over twenty feet and develop between 30,000 and 50,000 horse-power.

CRAWFORDSVILLE, IND.—The city council has under consideration a proposition for the sale of the city electric light plant and another proposition for furnishing the city with a new plant, the city to pay for the new plant, if accepted, on the yearly installment plan for ten years. An Anderson man, representing, it is supposed, a New York concern, has offered the city $46,000 for the plant.

HOTCHKISS, COLO.—At a meeting of the council J. Walter Lee, representing the Colorado Fruit Company and the Hotchkiss Packing and Power Company, composed of local and eastern capitalists, was awarded a twenty-year electric franchise. The company is organized for the purpose of furnishing the town with electric lights, also for running a canning factory and evaporator. They will begin operation January 16, 1908.

PORTLAND, ORE.—A subway system for gas, water and sewer mains and for all telephone and electric light wires, covering the territory between First and Sixteenth streets on the east and west and between Jefferson on the south and Glisan on the north, has been outlined by a joint committee of the city council and the executive board. The conduits are to run parallel with the river, and it is the intention to tax benefited property for the expense.

SODUS, N. Y.—The Public Service Commission has granted the petition of the Sodus Gas and Electric Light Company to extend its lines from Sodus to Webster and to Sodus Point and to increase its capital stock from $15,000 to $90,000. This will benefit the residents of Sodus Point, Wallington, Sodus, East Williamson, Williamson, Ontario, Ontario Center, Union Hill and Webster, as the Sodus company expects to extend its lines rapidly and serve these villages with both day and night service.

WASHINGTON, D. C.—R. W. Hersey, of San Jose, Cal., has been granted a permit by the Forest Service to occupy a right of way on the Stanislaus National Forest Reserve, and to construct thereon a transmission line for transmitting electric power for commercial purposes. The line will be located about twenty miles southwest of Sonora, beginning at the Tuolumne Electric Company's power house. The line will furnish electricity to the towns of Tuolumne, Soulsbyville, Confidence and Carter.

SPRINGFIELD, MASS.—The annual report of the Northampton Electric Lighting Company shows assets of $17,081, and liabilities of $135,987. The operating account shows operating expenses of $38,335; receipts from sale of light and power, $65,844; receipts from other sources, $1,311. The principal items in the profit and loss account show the following: receipts, balance of last year, $70,241; balance of manufacturing account, $28,820; disbursements, dividends, $4,675; depreciation, $43,578; balance to new account, $40,093.

CLEVELAND, OHIO—To light the streets electrically will cost the city $18,468 less in 1908 than it did in 1907. The only bid for lighting the streets in 1908 received by the board of public service was that of the Cleveland Electric Illuminating Company. The company offered a tender of $54.96 per lamp. Last year the city paid the illuminating company $67.92 per lamp. The saving on each lamp next year will be $12.96. There are 1,425 arc lamps in the city. The total saving will therefore be $18,468, nearly twenty per cent of the cost this year.

RENO, NEV.—R. P. Fairbanks and James Swanson, representing the Telluride Power Company, of Telluride, Colo., are purchasing sites along the Carson river for electrical power plants. They intend to build at least two plants and to furnish electric power for

mining camps in the western part of the state, as well as compete with the Truckee River General Electric Company, which now furnishes power to Reno, Carson and Virginia City. They are also interested in power plants in Provo Canyon, which furnish light and power to Salt Lake City.

COLORADO SPRINGS, COLO.—A reduction of ten per cent in the rates of the Colorado Springs Electric Company, to take effect January 1, has been announced. Instead of twelve and one-half cents per kilowatt-hour, the rate now in effect, the price for current furnished after January 1, 1908, will be eleven cents per kilowatt-hour, with a discount of one cent per kilowatt-hour if bills are paid on or before the tenth of each month. Instead of the minimum guarantee per month of $1.50, now in effect, with a discount of ten per cent, the new minimum guarantee rate applying on bills rendered on and after February 1, 1908, will be $1.25, with a discount of ten cents.

TAUNTON, MASS.—The report of the superintendent of the municipal electric light plant for the year ended November 30, 1907, shows the following figures: The income for current furnished to commercial customers for the year was $58,452.32, which is an increase over last year of $3,363.73. The total amount paid for operating expenses was $43,211.44. Deducting from this amount the sum of $2,270.84, for the increase of material on hand, such as coal, oil, waste, carbons, etc., the net cost of operation was $40,940.60, which shows a slight increase. The number of lights now in operation is 720, of which 274 are enclosed arc and 446 incandescent.

TORONTO, ONTARIO—At a largely attended meeting of the shareholders of the Stark Light and Power Company it was stated that over and above the liabilities of the company, $100,000 is available. The object of the meeting was to reorganize the company, and from statements made it was found that the several plants of the company were operating on a paying basis. The company was said to be really solvent, although E. R. C. Clarkson has been appointed liquidator. It was stated that the troubles of the company were in the taking over of a plant at Welland. Litigation in connection with it followed, and coupled with the stringency of the money market, caused a failure. The outlook was so promising that a committee of ten was appointed by the shareholders to reorganize the company.

MONTICELLO, IND.—The Tippecanoe Electric and Power Company has been incorporated with a capital of $75,000, which has for its object the development of the water power in the Tippecanoe river. By this method it is hoped to locate factories here which will obtain their power from the company. The directors of the new company are: Abram S. Strouss, Henry Meyers and J. Garrett Smith, all of Chicago. They have secured a fifty-year lease from W. T. Wilson, owner of the present water power, and have been granted a franchise for lighting the town of Monticello for twenty-five years. At present there is a dam across the river just above Monticello which furnishes power for a flouring mill. It is the purpose of the company to tear down the mill and erect a concrete power-house and also to supplant the dam with a new one to be four feet higher. Mr. Strouss is president of the Frankfort and Delphia interurban line and will extend his line through this city on to Chicago.

EDUCATIONAL NOTE.

RENSSELAER POLYTECHNIC INSTITUTE—The Rensselaer Polytechnic Institute, Troy, N. Y., announces that it has inaugurated courses in mechanical engineering and electrical engineering leading to the degrees of M.E. and E.E. These courses will be of the same character and thoroughness as have made this institution's course in civil engineering famous for the past three-quarters of a century. The gift of $1,000,000 by Mrs. Russell Sage insures complete laboratories in mechanical and electrical engineering.

OBITUARY NOTES.

DR. COLEMAN SELLERS, the distinguished engineer, died at his home, 3301 Baring street, Philadelphia, Pa., on December 28, at 7.30 P. M. Two sons, Coleman Sellers, Jr., and H. W. Sellers, and a daughter, Mrs. S. W. Colton, survive.

MR. JOHN W. McNAMARA, well known among New York state electric railway men, died on December 20 at his home in Albany, N. Y., after a lingering illness. He was connected with local surface lines from 1864 until January 1, 1906, when the Delaware & Hudson took control of the United Traction Company, of which he was president.

INDUSTRIAL ITEMS.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, is distributing a pretty calendar for 1908 to its patrons.

THE ELECTRIC SERVICE SUPPLIES COMPANY, Philadelphia, Pa., has made a change in its St. Louis, Mo., office, N. P. Hall temporarily succeeding Ernest Boehme, formerly manager of the St. Louis branch. A rearrangement of the personnel of the branch will be made early in the year.

THE HARVARD ELECTRIC COMPANY, 66 West Van Buren street, Chicago, Ill., has placed on the market a self-welding wire joint for splicing both iron and copper wires. Full information concerning this joint will be sent to those interested upon application.

THE W. R. GARTON COMPANY, Chicago, Ill., announces the retirement of W. R. Garton from the company and his association with the Lord Electric Company, of New York city. Ray P. Lee succeeds Mr. Garton as president and treasurer, and A. F. Henderson succeeds Mr. Lee as secretary of the W. R. Garton Company.

THE BRISTOL COMPANY, Waterbury, Ct., has been awarded a silver medal for its recording instruments exhibited at the Jamestown Exposition. These recorders have received high awards at every exhibition in which they have been entered as competitors in recent years, including those held at Paris, Chicago and St. Louis.

THE LOCKE INSULATOR MANUFACTURING COMPANY, Victor, N. Y., has favored some of its patrons and friends with a calendar for 1908, the mat of which shows the beautiful creation "Nathalie," by Alfred Schwarz, the original of which was exhibited at the "Grosse Ausstellung" (great exhibition) at Berlin in 1906, and secured for Herr Schwarz the royal favor of Kaiser Wilhelm.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., in bulletin No. 2034 describes and illustrates the motor applications at the Fore River Shipbuilding Company's yard at Quincy, near Boston, Mass. The generator is operated on the two-wire plan, supplying the highest voltage—240 volts—and all the constant-speed motors, crane motors and the lighting system of the yard are operated at this voltage. For variations of speed this voltage is divided into three by means of a balancing transformer, and by proper combinations a number of pressures may be obtained. The system is one in which the impressed electromotive force upon the armature of the motor is changed to meet the requirements of speed regulation. Copies of this bulletin will be sent to those interested upon request.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has published a very interesting and instructive bulletin entitled "The Polyphase Motor in the Shop." This bulletin deals with the adaptation of polyphase motor drive to the heavy machinery necessary in car building and locomotive works and is illustrated with views made in the shops of the Wabash Railroad Company, at Decatur, Ill., the motor equipment of which was furnished by the Wagner Electric Manufacturing Company. The results from this installation have exceeded in every respect the expectations of the officials of the railroad company and have attracted considerable attention in railway circles. The bulletin gives a large number of illustrations of applications of these polyphase motors. Bulletins describing the apparatus specifically will be furnished to those interested upon request.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., describes in bulletin No. 4550 a number of its well-known lines of circuit-breakers. Type C, form G circuit-breakers are designed for a small, reliable, automatic, protective device for direct and alternating-current systems at a moderate price. Type C, form P, are particularly adapted for use on railway and power systems which are frequently subjected to severe short circuits and heavy overload. They are made up to 12,000 amperes capacity. Type C, form K, especially designed for heavy service, are particularly well suited for railway work. They are made in capacities up to 10,000 amperes. The bulletin also contains descriptions of auxiliary switches, automatic tripping devices, etc., to be used with the circuit-breakers and gives complete data as to capacities, prices and dimensions of the devices shown. The bulletin contains thirty-six pages and is conveniently arranged for reference.

Record of Electrical Patents.

Week of December 24.

874,411. SYSTEM OF ELECTRICAL TRANSMISSION AND PROPULSION. Maurice Leblanc, Paris, France, assignor to Westinghouse Electric and Manufacturing Company. A transmission line for alternating currents of short wave length, in which the ratio of the capacity to the self-induction is increased at points along the line.

874,483. ELECTRIC FIRE AND BURGLAR ALARM. Melancthon J. Briggs, Philadelphia, Pa. An alarm system which gives visual as well as audible signals.

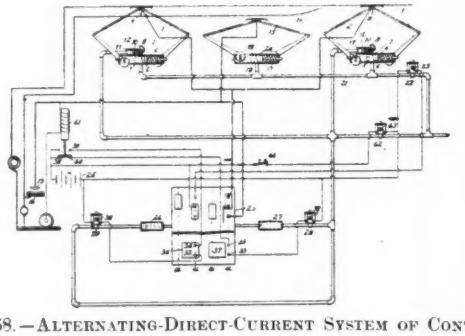
874,508. BRAKE FOR ELECTRIC CARS. Moses G. Hubbard, Jr., Austin, Ill. The brakes are actuated by a motor driven by one of the car motors which operates as a generator.

874,511. INTERRUPTER. William Kaisling, Chicago, Ill., assignor to Milo G. Kellogg, Chicago, Ill. The vibrator has a primary movement in one direction and a secondary movement transversally.

874,531. AUTOMATIC MOTOR STARTER. William C. O'Brien, Baltimore, Md., assignor to Monitor Manufacturing Company, Baltimore, Md. A starting resistance is shunted by a circuit containing two switches, one of which closes the motor circuit and the other opens it in the case of excessive current.

874,558. ALTERNATING-DIRECT-CURRENT SYSTEM OF CONTROL. Howard L. Beach, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. A control system which brings into action the respective collecting devices depending upon whether the supply system is direct or alternating.

874,559. SYSTEM OF CONTROL. Howard L. Beach, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. A switch in a control system which brings into action either one of two collecting devices.



874,558.—Alternating-Direct-Current System of Control.

874,564. ELECTROLYTIC APPARATUS FOR THE MANUFACTURE OF NITROCELLULOSE. Gaston C. de Briailles, Paris, France. The treating chamber is divided by a porous partition and two electrodes are placed in one compartment of this chamber, one being near the partition.

874,567. ELECTRIC CONTROLLER. Roy W. Brown, Amsterdam, N. Y. A magnetic release for motor starters.

874,601. SWITCH FOR HIGH-POTENTIAL CIRCUITS. Joseph N. Kelman, Los Angeles, Cal. An oil switch with a toggle motion.

874,602. TELEGRAPH KEY. John P. Kinney, Pocatello, Ida. An operating member which spans the instrument is carried by the key lever.

874,608. DANGER SIGNAL. Clevia J. Luther, Desloge, Mo., assignor of two-fifths to James T. Mayberry, Desloge, Mo. A signal for structures exposed to dangerous conditions, which is actuated by a float.

874,630. THIRD-RAIL ATTACHMENT FOR ELECTRIC CARS. George H. Sohn, Lincoln, Cal. A hollow third-rail and collecting device therefor.

874,690. LINE-TESTER. Edwin S. Lincoln, Brookline, Mass. A telephone provided with a short-circuiting key.

874,745. TELEGRAPHY. Patrick B. Delany, South Orange, N. J. A system of wireless telegraphy.

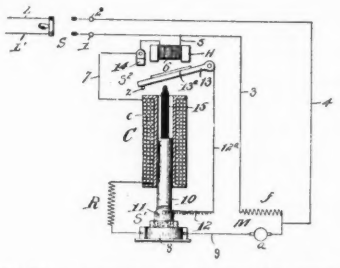
874,780. THERMO-ELECTRIC ELEMENT. Albert L. Marsh, Lake Bluff, Ill., assignor to Wm. A. Spinks & Co., Chicago, Ill. The couples are formed of vanadium and a metal which, when alloyed with the former, gives an alloy electro-negative to nickel.

874,795. SAFETY-FUSE. Joseph Sachs and Frank D. Reynolds, Hartford, Ct., assignors to The Sachs Company, Hartford, Ct. An enclosed fuse the contact blades of which pass through the walls of the casing but not through the end caps.

874,796. SAFETY-FUSE. Joseph Sachs and Frank D. Reynolds, Hartford, Ct., assignors to the Sachs Company, Hartford, Ct. A fuse with an indicating device connected to one edge of an end cap.

874,797. SAFETY-FUSE. Joseph Sachs and Frank D. Reynolds, Hartford, Ct., assignors to the Sachs Company, Hartford, Ct. A safety fuse with an indicating device placed in a perforation of one end cap.

874,798. SAFETY FUSE. Joseph Sachs, Hartford, Ct., assignor to the Sachs Company, Hartford, Ct. Two coiled wires attached by a fusible joint.



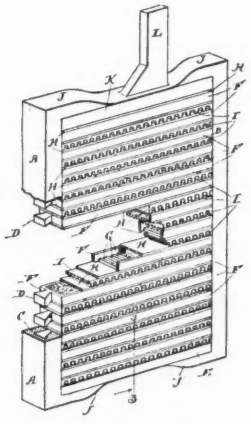
874,531.—Automatic Motor Starter.

874,826. NULLIFYING DISTURBANCES IN TELEGRAPHIC OR OTHER SIGNALING CIRCUITS. Edward Blakeney, Ossining, N. Y., and Robert E. Chetwood, Jr., Elizabeth, N. J., assignors to American Telephone and Telegraph Company. A line for simultaneous telegraphic and telephonic communication.

874,834. INSULATOR AND PROTECTOR FOR ELECTRIC CONDUCTORS. Thomas C. Copping, Houston, Tex. A divided, slotted insulator.

874,841. STORAGE-BATTERY PLATE. William Gardiner, Chicago, Ill., assignor, by mesne assignments, to Commercial Storage Battery Company, Chicago, Ill. A plate built up of transverse bars with absorbent material placed between.

874,868. TELAUTOPHOTE. Sidney Rothschild, New York, N. Y. A system for transmitting pictures which utilizes a light-controlled cell.



874,841.—Storage-Battery Plate.

874,869. CONTROL SYSTEM FOR ELECTRIC VEHICLES. Olof A. Sandborgh, Swissvale, Pa., assignor to Westinghouse Electric and Manufacturing Company. A system for automatically completing a circuit through either of two collecting devices.

874,898. AUTOMATIC STARTING-BOX. Thomas M. Morris, New Haven, Ct., assignor of one-fourth to Frederick P. Lewis and one-fourth to Edward H. Everit, New Haven, Ct. A starting-box automatically controlled by a small motor.

874,908. APPARATUS OR MEANS FOR THE PRODUCTION, TRANSMISSION AND DISTRIBUTION OF ELECTRIC CURRENTS. Charles E. Fritts, New York, N. Y.; Josephine H. Fritts, administratrix of said Charles E. Fritts, deceased, assignor of one-third to Spencer B. Prentiss, Washington, D. C. A system containing condensers which are alternately charged and discharged.